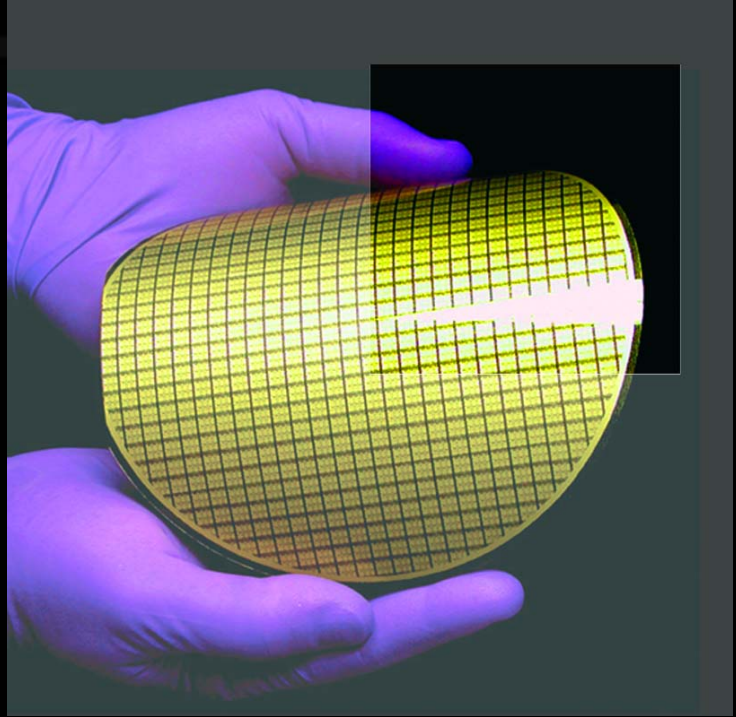


Technology Applied



*T*hanks to all the companies for their participation in this Missile Defense Agency (MDA) technology transfer publication. We appreciate the time and effort it took to compile and share their stories, details, and graphics.

For press inquiries, contact:

Director, Communications
MDA/DC
7100 Defense Pentagon
Washington, DC 20301-7100

E-mail external.affairs@mda.osd.mil

For comments, questions, and additional copies, contact:

National Technology Transfer Center-Washington Operations
2121 Eisenhower Avenue, Suite 400
Alexandria, VA 22314

Telephone (703) 518-8800, ext. 500
Facsimile (703) 518-8986
E-mail techapps@nttc.edu
Web site www.mdatechnology.net

MISSILE DEFENSE AGENCY
2003 TECHNOLOGY APPLICATIONS REPORT



Foreword

Developing a successful defense against ballistic missile attacks has always been a challenging task for the Missile Defense Agency (MDA) and its predecessors, the Ballistic Missile Defense Organization (BMDO) and the Strategic Defense Initiative Organization (SDIO). Many engineering complexities and operational realities are associated with ballistic missile defense. These issues are not overcome overnight. To shorten the years it may take to achieve a deployable defense, MDA invests substantially in advanced technology development.

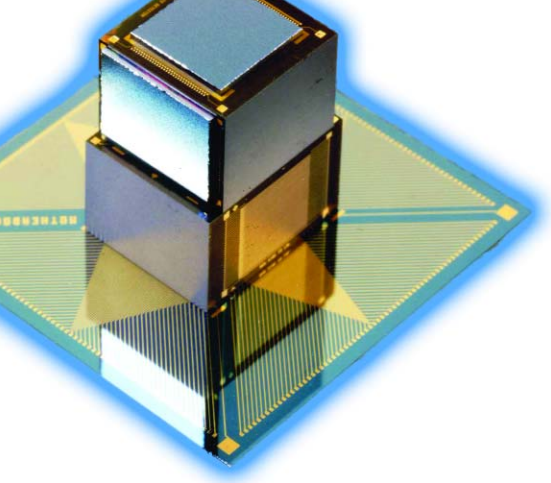


Through programs sponsored by MDA's technology development offices, U.S. businesses are working diligently for MDA to push forward the limits of science and engineering. Many invaluable technologies and products with applications for both MDA and the private sector are a direct result of these programs. When businesses find viable commercial markets for their MDA innovations, they grow significantly and mature their technologies, creating new jobs and new industries across the country. They also create new products that provide substantial economic and social benefits.

In this year's edition of the Technology Applications Report, I am proud to highlight 24 examples of MDA-funded technologies that have reached commercial markets. These technologies are making important contributions to our Nation's economy in areas such as communications, counter-terrorism, electronics, lithography, medicine, power generation, and sensing, to name just a few. They provide strong evidence that technological innovation is not dead. In fact, it is clearly alive and kicking!

A stylized, handwritten signature in black ink, appearing to read 'Paul Koskey'.

Paul Koskey
Director, Technology Applications Program



“Through programs sponsored by MDA’s technology development offices, U.S. businesses are working diligently for MDA to push forward the limits of science and engineering.”

—Paul Koskey

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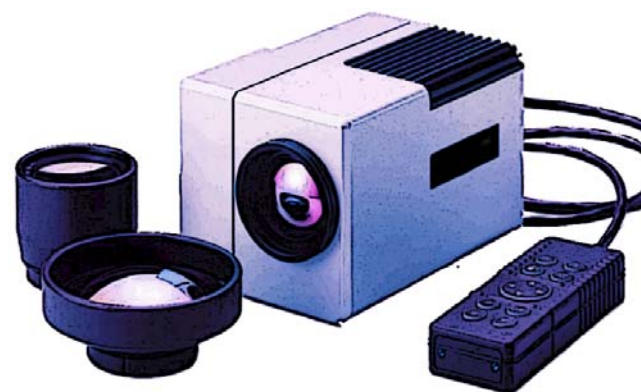
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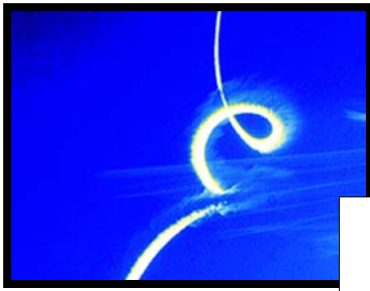


*There ain't no rules around here. We're
trying to accomplish something!*

—Thomas Edison

Introduction





The Missile Defense Agency (MDA) invests in innovative technologies to help defend the United States and its allies from increasingly sophisticated ballistic missile threats. From its inception, MDA and its predecessors, BMDO and SDIO, have supported the development of these technologies for integration into weapon systems as well as for spinoffs into commercial applications.

Introduction

Develop

Q: *Why is the Missile Defense Agency (MDA) funding the development of advanced technology?*

A: Antimissile defenses cannot be developed overnight. Yet the threat of ballistic missile attack continues to grow. Significant leaps in technology are needed to make the vision of superior missile defense a reality. These leaps offer the potential to push forward the boundaries of known science and engineering to allow scientists and engineers to create ever-more-sophisticated technology. With such technology, MDA can strengthen its ballistic missile defenses—by making them more accurate, robust, capable, and affordable. Reaping such benefits, however, is not without significant risk. Sometimes, a large investment must be made to make the very discovery that overcomes a key technology barrier.

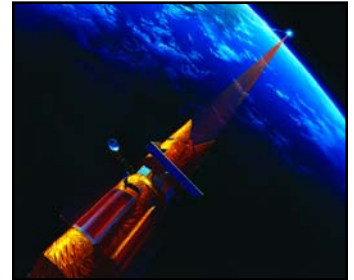
Q: *What kinds of technology are being developed?*

A: Advanced research and development (R&D) projects are concentrated in algorithms, electronics, materials, photonics, power, propulsion, sensors, and thermal management. For example, laser radars are needed to locate and track missiles throughout their trajectory, while algorithms are key to discriminating between real and decoy missiles. Nanopowders—materials with diameters significantly smaller than the width of a strand of hair—could make

infrared seeker windows harder and more transparent. Heat sinks could provide interceptors with much-needed thermal management, preventing sensitive electronics from overheating. Solar cells could provide satellite electronics with more power, extending a platform's surveillance duties in space.

Q: *Who develops this technology?*

A: MDA does not operate any development facilities or laboratories of its own, so it depends largely on the military branches and other Federal agencies for technology management. While large businesses perform the majority of technology development work, small businesses and universities are also important technology contributors. Through programs such as MDA's Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Innovative Science and Technology, and in-house advanced concepts and advanced systems, these organizations test the scientific and technical merit of advanced technology concepts.



Transfer

Q: *Why transfer this technology to commercial markets?*

A: MDA supports technology transfer for several reasons. Transferring MDA-funded technology to commercial markets can reduce its cost through quantity production. It can also prove a technology's reliability and improve its performance. Often, these benefits are realized without additional MDA funding because the technology developers leverage private R&D funds. However, in the final analysis, MDA funds technology to meet its mission of ballistic missile defense.

Technology transfer supports the mission when it keeps MDA-funded technologies alive for MDA acquisition decisions. For example, suppose a small technology company develops a tiny accelerometer to help guide a ballistic missile interceptor, but it will be years before this technology is inserted into a missile defense system. Without any sales, the company may go bankrupt. To survive, it finds an automobile manufacturer that needs a new triggering mechanism for its air bag deployment systems. By reducing the size and cost of the accelerometer while increasing its accuracy, the company sells the device in mass quantities to the automobile manufacturer. By creating a new revenue source, it can stay in business and be ready to supply the technology when MDA is ready to insert the technology into the interceptor.



Technology transfer responds to public law and Department of Defense (DOD) policy. More than 20 different Federal laws and directives promoting technology transfer have been enacted. Key laws include the Stevenson-Wydler Technology Innovation Act (1980), which required Federal laboratories to facilitate the transfer of federally owned and originated technology to state and local governments and the private sector. The Bayh-Dole Act (1980) enabled universities and other nonprofits to own and patent inventions resulting from federally funded research programs. Presidential Executive Order 12591 (1987) directed Federal agency heads to help transfer technology to the marketplace, and granted title to innovations growing out of federally funded research to the institutions that performed the research. DOD Directive 5535.5, "DoD Domestic Technology Transfer (T2) Program," re-established DOD's policy of support and participation in technology transfer.

And finally, technology transfer provides substantial economic and social benefits. To transfer a technology to the commercial sector, several things must happen. A new business must be formed to create a product from the technology, find customers, and generate sales. Employees must be hired to perform the administrative, engineering, and marketing functions. So technology transfer results in the creation of new businesses and jobs. When these businesses bring new technology to the marketplace, it also increases the economic competitiveness of the United States.

Q: *Who assists this technology transfer?*

A: The MDA Technology Applications program is responsible for the transfer of MDA-funded technology to the commercial sector. The National Technology Transfer Center-Washington Operations (NTTC-WO) supports the program through a cooperative agreement with MDA. Established in 1993, NTTC-WO has a proven track record of supporting the MDA Technology Applications program, and helping organizations to transfer their MDA-funded technologies to the commercial sector. Its unique approach to MDA technology transfer includes business assistance and outreach support services.

Assist

Q: *How does NTTC-WO assist all MDA technology developers?*

A: To help companies close to product release focus on applications issues needed for success, NTTC-WO offers the Technology Applications Review (TAR). The TAR can be compared to a board of directors meeting. Researchers



present summaries of their MDA-funded innovations to a panel of business experts, emphasizing their commercial applications. The presenters and the panel then discuss the commercial potential of the innovation as well as the performance and financial milestones. Presenters may benefit from the process by learning of potential new applications, markets, business opportunities, and customers. They also receive feedback on timeliness, valuation, market prospects, and likely competition. Another key benefit is that presenters are given contacts in manufacturing, sales, financing, and intellectual property.

Q: *How does NTTC-WO assist first-time SBIR award winners?*

A: To assist first-time SBIR award winners, NTTC-WO offers the Business Focus Workshop (BFW). The BFW is designed to help young companies detect and resolve technology development and business issues early. It involves a one-day intensive meeting in which a representative of a small technology company is teamed with an NTTC-WO commercialization engineer and a business consultant. The group works independently for four hours, covering a detailed topic list of business development issues such as market applications, sales projections, marketplace benefits, competition, intellectual property, and finance strategy. During the session, the company representative prepares a presentation that concisely summarizes the business case for the company's product. The day concludes with the representative presenting to a larger group of business and technology experts who provide targeted feedback and strategic advice.



Q: *How does NTTC-WO assist MDA with technology identification?*

A: NTTC-WO is managing a new technology transfer demonstration project called the Commercial Technology Exploitation (CTE) Initiative. CTE hopes to identify commercial, non-defense technologies that can enhance missile defense capabilities and forge relationships between MDA Program Elements and commercial industry. The challenge of the CTE program will be to fully understand and prioritize key capability enhancements suitable for such a demonstration and translate them for non-defense industry experts to use effectively. If all goes well, successes could provide significant savings in research, development, and scale-up costs while providing a better-performing solution.

Promote

Q: What types of publications does NTTC-WO produce to help MDA-funded companies promote their businesses?

A: For the MDA Technology Applications program, NTTC-WO develops a wide variety of publications that feature MDA-funded technologies and their developers. Perhaps the most visible publication is the quarterly *MDA Update*

newsletter, which features 10 to 12 new MDA-funded technologies with promising commercial applications. Distributed to more than 7,000 people involved in technology transfer and commercialization, the newsletter helps featured companies gain additional networking contacts and opportunities for successful business ventures. Technology developers also receive reprints of their newsletter article to distribute at business meetings and conventions.

Special reports are developed to highlight MDA-funded technologies that can be grouped together by application area. The *Technology Applications Report*, produced yearly, features MDA's top success stories in the areas of communications, computing, electronics, imaging, materials, and sensors. To help in the war on terrorism, *Missile Defense Technologies: Tools to*

Counter Terrorism was developed to highlight MDA-funded technologies that law enforcement organizations and security companies can use to prevent further attacks. Other singularly focused reports have been published on technologies for aviation safety, biomedicine, electric utilities, fiber optics, and the environment.

Q: How is information about MDA technology transfer made available via the Internet?

A: Through a successful demonstration project, NTTC-WO developed mdatechnology.net, an Internet portal that provides information about MDA technology transfer. The site features background articles on MDA-funded

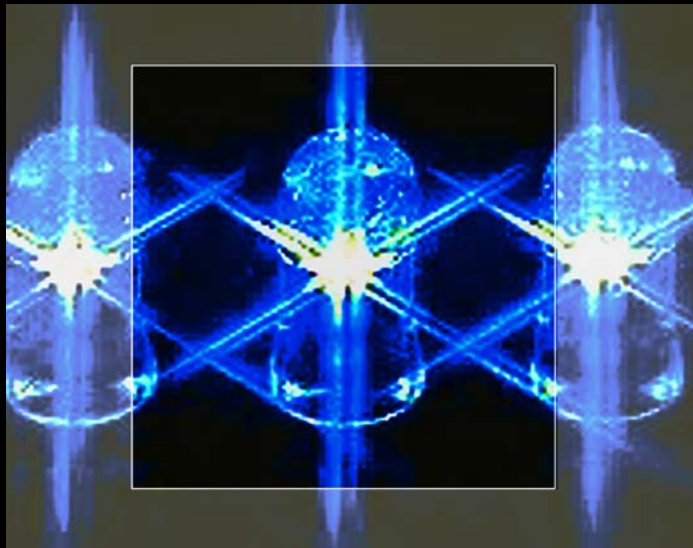


technologies, which can be easily and quickly searched. It also provides links to press releases from companies that are commercializing MDA-funded technologies. Digital versions of all MDA technology transfer publications also are available. In addition to mdatechnology.net, NTTC-WO maintains the technology transfer section of MDALINK, MDA's official presence on the Internet.

Q: *How else are MDA-funded technologies promoted?*

A: NTTC-WO staff often exhibit at technical conferences and meetings to disseminate information about MDA technology transfer opportunities. Recently attended events include the Materials Research Society meeting, Photonics East/West, and the Space and Missile Defense Conference.





*Man will occasionally stumble over the truth, but most
of the time he will pick himself up and continue.*

—Winston Churchill

Ceramic, Composite, and Electronic Materials

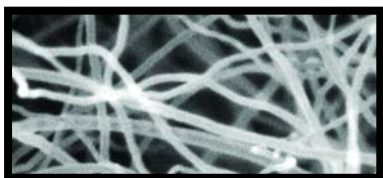




A company that manufactures polymer-based lithium-ion batteries for portable electronics would like to enhance the electrically conductive properties of an experimental polymer. It wants to maintain structural and thermal integrity while not significantly adding to the weight of a cell. Here is a product that can add conductive properties without adding weight.

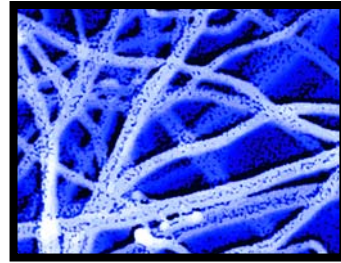
Pyrograf[®]-III

How It Helps: Pyrograf-III provides polymers with electrically conductive properties, as do regular milled carbon fibers or carbon black. The advantage of adding nanofiber is twofold: it does not disturb the other properties of the polymer, and the nanofiber takes only up to 5 to 20 percent of the volume required by bulkier additives. Another advantage is in the process of making Pyrograf-III itself. The use of sulphur dramatically improves the nucleation efficiency of carbon nanofibers. High-sulfur coal can be mined, not as a source of fuel for power plants, but rather as a chemical source of hydrocarbons.



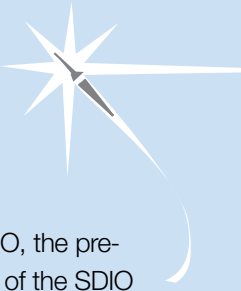

How It Works: The Pyrograf-III composite material is produced by introducing a gas-phase catalyst into a heated hydrocarbon atmosphere. This creates carbon nanofibers having diameters of 100 to 200 nm. When added to polymers, carbon fibers convert the polymer from an insulating material to an electrically conductive material. The Pyrograf-III-based composite can be formulated to have electrical resistivities anywhere from 100 to 10¹⁰ ohm-cm. Concentrations as low as 0.5 percent have been shown to produce resistivities as low as 10⁴ ohm-cm in injection-molded thermoplastic composites. Additionally, carbon nanofiber has a thermal conductivity of between 1,950 and 2,000 W/m-K, or close to five times that of copper.

How Much It Will Cost: The price is \$85 to \$110 per pound or less depending on the size of the order.



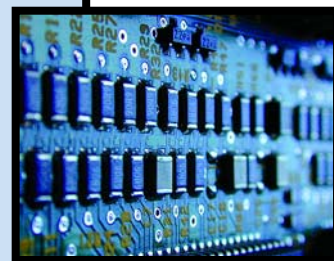
When It Will Be Ready: The product is available now. A pilot plant is producing 70,000 pounds per year of the composite. The existing production capacity from the pilot plant is sold out, but there are plans to double capacity.

Who Is Working On It: The innovator is Applied Sciences, Inc. (ASI). ASI, which specializes in the research and development of advanced materials and their applications, incorporated in 1984. As of November 2001, the company had annual sales of \$1.5 million and employed 33 people. Pyrograf Products, Inc. (PPI), created in 1996, is an ASI subsidiary. PPI operates a modern 70,000-pounds-per-year facility in Cedarville, Ohio. The Pyrograf-III pilot plant is housed in a 22,200-square-foot facility. For more information, contact Kate Monaghan of ASI at (937) 766-2020, ext. 105, or monaghan@apsci.com. The company Web site is www.apsci.com.



MDA Origins

As early as 1987, ASI received funding from SDIO, the precursor to BMDO, and MDA. Since the inception of the SDIO program, ASI has received 12 SBIR Phase I contracts, three SBIR Phase II contracts, and an STTR Phase I contract to study and develop various carbon composite technologies for structural, thermal, and electronic applications. With funding from SDIO, DOE, and the U.S. Air Force, ASI began to study applications for the nanofibers. It joined forces with General Motors (GM) and licensed all of GM's intellectual property on the composites. In 1996, ASI, GM, Goodyear Tire & Rubber Company, and others joined together in a cooperative research agreement and received funding from NIST's Advanced Technology Program.





A violent explosion rocks a large downtown office building. Hundreds of people must be rescued. Firefighters and rescue personnel believe the area is contaminated by hazardous chemicals. Complicating matters, people evacuating the building may inhale harmful airborne particles. Here is a product that could help protect these people.

Escape Mask

How It Helps: The escape mask uses microfibrous filter technology that traps toxins and irritants ranging from sarin and anthrax to pollen and dust mites. It is lightweight, foldable, and fits inside a shirt pocket. Small and compact, it can be easily carried and distributed by the hundreds to protect people from harmful air threats. Unlike today's gas masks, the escape mask offers a lower pressure drop so it makes breathing easier—a must for the elderly or young children. The microfibrous technology can be tailored to anticipated threats such as a "cocktail" attack with a combination of chemical agents. It can be recharged simply by being reheated.



How It Works: The microfibrous filter technology contains sorbent materials in a mesh of carbon-metal composite and cellulose wood fibers that, under a microscope, resembles a wad of chicken wire. This matrix has high electrical conductivity and high surface area (about 1,000 square meters per gram). The fibers are then put through a paper machine on a roll, and the resulting sheets are sent through a furnace at 1,000°C, which melts the fibers and fuses them together. The sheets are then cut into strips and placed in canisters for use in the escape masks.



How Much It Will Cost: The target price of the escape mask is less than \$150. Other types of escape masks currently on the market cost more.

When It Will Be Ready: The escape mask will be available during the first quarter of 2003. Initially, it will be distributed to the first-responder market for use in emergency situations, such as terrorist attacks or building fires. Additional microfibrinous filter products are being developed. Air security products include a chemical/biological filter for commercial and government facilities. The first air-quality product will be a replacement filter for home use.



Who Is Working On It: The innovator is IntraMicron, Inc. Formed in 2001, the company develops filter products for personal and facility protection, as well as for air quality assurance.

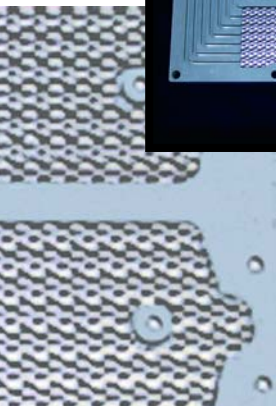
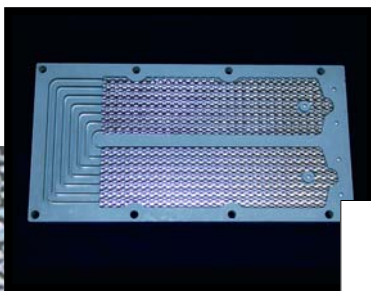
It has an exclusive worldwide license for the microfibrinous filter technology from Auburn University, where Dr. Bruce Tatarchuk invented the technology. The company recently secured more than \$1 million in early-stage venture funding. It employs seven people and occupies 2,000 square feet of office space in Birmingham, Alabama. A new 14,000-square-foot manufacturing facility with office space in Gahanna, Ohio, also has been leased. The company plans to move into this facility by mid-2003. For more information, contact John Stein of IntraMicron at (205) 443-4670 or stein@intramicron.com. The company Web site is www.intramicron.com.



MDA Origins

The carbon-metal composite used in the microfibrinous filter technology originally was developed by Auburn University's Space Power Institute with funding from BMDO's Innovative Science & Technology program. The material would be ideal for use in developing advanced capacitors to power lasers, railguns, and other weapon systems. Fuel cells and batteries made from the material also could provide power for space-based platforms.





A metal foil factory with a high-speed, in-line continuous production line uses precision die-cutting equipment to reduce waste and improve profits. However, the cemented tungsten carbide cutting edges are difficult and expensive to apply. Here is a product that can affordably bond the cutting edges to the tooling.

S-Bond™

How It Helps: The S-Bond joining process bonds dissimilar materials at low temperatures, providing new joining solutions for wear surface, thermal management, and metal-to-ceramic material applications. It can replace gluing, mechanical fastening, welding, brazing, and soldering. S-Bond's advantages over gluing include ease of rebonding, lack of volatilization or lengthy curing time, and high thermal conductivity (about 50 W/m-K). The new joining method also is less environmentally damaging than competing technologies. S-Bond uses unique alloys to actively join dissimilar materials (including metals and ceramics) without the need for special atmospheres or harsh flux chemicals.




How It Works: S-Bond lead-free alloys join even dissimilar materials in a simplified and more cost-effective way than soldering and brazing, using the same fundamental procedures. The process joins composites, ceramics, and metals, as well as graphite or any other carbon-based material. The S-Bond alloys are created by adding reactive elements, such as titanium and other active elements, to conventional solder alloy bases. In the S-Bond alloys, the active elements migrate to the joint interface and react with the joint surface compounds. Once up to temperature and molten, the S-Bond alloys become "active," permitting the active elements to diffuse into the surface of the two opposing joint materials to form a metallurgical bond. S-Bond "activation" is accomplished by pressure, brushing, and vibration, or any combination of the three.

How Much It Will Cost: Prices for S-Bond kits range from \$280 to \$995; prices for S-Bond materials range from \$190 to \$450 per pound.

When It Will Be Ready: The technology is available now. S-Bond materials are sold to electronics, electronic and optoelectronic packaging, heat exchanger, and industrial companies that are joining aluminum, stainless steels, other metals, ceramics, and composites. S-Bond's ability to behave like a glue while being a metal filler offers many opportunities for the sale of S-Bond alloys, equipment, and services. S-Bond sales were in excess of \$250,000 in 2002.



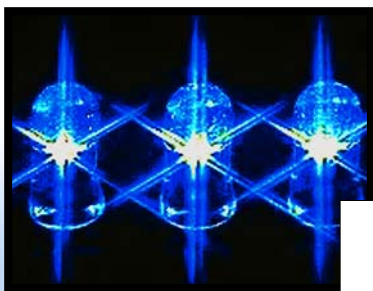
Who Is Working On It: In 2002, Materials Resources International (MRi) created S-Bond Technologies (SBT) to focus on commercial opportunities for its active solder technology. MRi employs six people and occupies approximately 6,500 square feet of office space and manufacturing facilities. In North America, SBT is responsible for the technology of lead- and flux-free, active solders that can join almost any combination of materials. While SBT benefits from MRi for its research needs, SBT serves major markets in electronics, ceramic metal joining, and simple dissimilar metals-intermetallics joining. SBT offers equipment, engineering services, and manufacturing/joining for customers. For more information, contact Dr. Ronald Smith of S-Bond Technologies at (215) 631-7111 or solution@mri-bluebell.com. The company Web site is www.s-bond.com.



MDA Origins

Throughout the 1990s, BMDO's Innovative Science and Technology program funded JPL to develop QWIP technology for use in ground-based and space-based infrared surveillance at long wavelengths. The technology could detect unheated objects such as ballistic missiles in mid-course when the hot rocket engine is not burning and most of the emission peaks are between 8 and 9 micrometers.





Blue light-emitting diodes (LEDs) based on gallium nitride (GaN) can be used to make new lighting products that consume power much more efficiently and last many years longer than conventional incandescent light bulbs. But the price of the GaN devices will be much higher than that of traditional bulbs because, during their manufacture, throughput is reduced and costly substrate materials must be used. Here is a product that could increase throughput and lower the cost of production for blue LEDs.

GaN-on-Sapphire Wafers

How It Helps: GaN-on-sapphire wafers can improve the mass production of blue LEDs. Using these wafers reduces growth time by more than 30 and allows an increase in production throughput of 30 to 50 percent—without incurring extra cost. The blue LED is grown directly on the surface of the substrate, eliminating the need for sapphire nitridization, GaN low-temperature nucleation deposition, and thick GaN buffer layer growth. The quality of the GaN LED structure is ensured by pre-growth inspection of the wafer, which is not possible with other methods of fabrication.





How It Works: GaN-on-sapphire wafers are fabricated using a technology called hydride vapor phase epitaxy (HVPE). HVPE involves reacting gallium metal with hydrogen chloride to make gallium chloride. The gallium chloride reacts with ammonia gas, and blue LED structures can be grown directly on the surface of the substrate. The HVPE process usually is carried out at atmospheric pressure in a quartz walled reactor heated by a resistive furnace.

How Much It Will Cost: The price of the GaN-on-sapphire wafers ranges from \$150 to \$700, depending on product specifications and purchase volume.

When It Will Be Ready: GaN-on-sapphire wafers are available now. These products are being manufactured at a rate of more than 1,000 per month, and that capacity is expected to increase by mid-2003. Clients include companies in the United States as well as in Japan, Korea, and Taiwan.

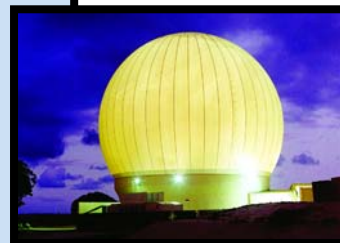


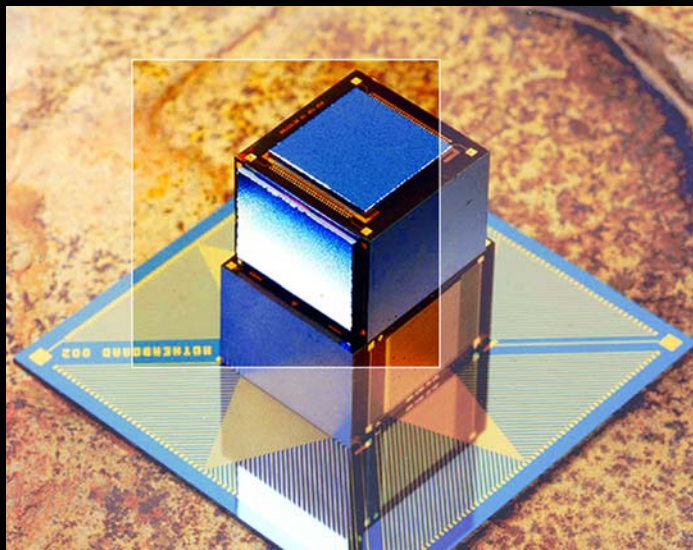
Who Is Working On It: The innovator is Technologies and Devices International, Inc. (TDI). Founded in 1997, TDI develops, manufactures, and markets bulk crystals, epitaxial structures, and devices using SiC, aluminum gallium nitride, and GaN semiconductor materials. The company employs 25 people and recently moved to a new 32,000-square-foot development and manufacturing facility in Silver Spring, Maryland. For more information, contact Dr. Slava A. Maslennikov of TDI at (301) 572 7834 or slava@tdii.com. The company Web site is www.tdii.com.



MDA Origins

In 1999 and 2000, TDI received SBIR Phase I and II contracts from BMDO to develop the HVPE process to deposit high-quality GaN layers onto sapphire and silicon carbide substrates. GaN devices could significantly improve BMDO communications systems. For example, radar and satellite-communications links, which operate at frequencies of hundreds of megahertz to tens of gigahertz, often have high power-amplification requirements that can be satisfied using GaN devices. GaN transistors would work in many of these units, conferring on them the solid-state advantages of ruggedness and portability.





*The whole of science is nothing more than
a refinement of everyday thinking.*

—Albert Einstein

Computing





ESO

A growing utility company operates a mixed fleet of more than 1,000 vehicles stocked with different sets of supplies and equipment. Its labor force contains both union employees and non-union contractors who operate with different rules and costs. The company needs to supply thousands of customers daily with new installations, maintenance, and repair. Here is a product that could help simplify this complex logistical situation.

How It Helps: Energy Service Optimization (ESO) software can help a company manage a mobile workforce more efficiently. It can reduce costs and improve efficiencies by 25 percent or more. It also can increase available resources, and improve response time, customer service, and customer satisfaction. This product can take into account more variables than competing tools and is easily customized to meet the special needs of customers. A flexible, modular solution, it provides the necessary tools to solve specific problems without overwhelming the user. The algorithms themselves originally were econometric and are therefore well-suited to the needs of the business world.





How It Works: To create the algorithms that drive the ESO software, researchers refined econometric models. Econometric models address the allocation of scarce resources, taking into account supply and demand, and are commonly used to set economic policy or make decisions on pricing, inventory, and production. As applied to service delivery, the software balances scarce resources and considers many critical factors—routing, appointment times, employee compensation plans, resource availability, skills, inventory, tasks, and customer preferences—to determine which staff member would best meet the demands of a given service call. This leads to more efficient staff deployment and service fulfillment.

How Much It Will Cost: The price for ESO software ranges from \$50 to \$200 per month per managed resource, and \$1,000 to \$4,000 per managed resource for a perpetual license. A managed resource is typically a field technician.



When It Will Be Ready: The software is now available. Leading companies in broadband, utilities, manufactured goods, and technology, such as Southern Union Gas, Time Warner Cable, BancTec, and John Deere, are using ESO software to optimize the economic performance of their service supply chain management operations.

Who Is Working On It: This product was developed by PointServe, Inc. Dr. G. Edward Powell founded PointServe in 1996 with the vision of applying economic optimization technology to service supply chain management. Today, PointServe is a full-service software company that offers management solutions and tools that increase capacity, improve customer service, and reduce costs. The company remains privately held and has received more than \$50 million in private investment. PointServe has approximately 40 employees and occupies about 10,000 square feet of office space in Austin, Texas, and several thousand square feet of data center space in Dallas, Texas. For more information, contact G. Edward Powell of PointServe at (512) 617-5300 or epowell@pointserve.com. The company Web site is www.pointserve.com.



MDA Origins

In 1988, Dr. Powell was a member of the technical staff at the Massachusetts Institute of Technology's Lincoln Laboratory, where he developed advanced forecasting, modeling, and simulation algorithms for autonomous satellite navigation. The algorithms were designed to allow BMDO's Midcourse Space Experiment satellite to control its own resources while optimizing observing time. These algorithms now represent the core of PointServe's ESO software solutions.

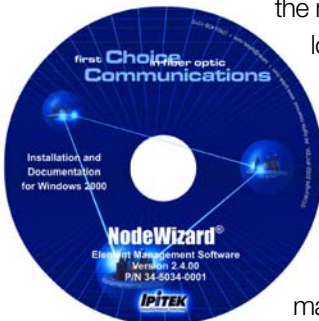




A building manager oversees hundreds of security cameras and electronic doorways. Unbeknownst to him, the flow of data to and from a critical network node stops. Fifteen minutes later, 10 cameras and 20 doorways shut down. Here is a product that could instantly alert the manager when a failure occurs.

NodeWizard®

How It Helps: NodeWizard software monitors critical elements of a distributed network, allowing operators to identify problems and initiate repairs before any loss of service occurs. Unlike competing products, the software manages not just voice networks and high-speed data networks but also video networks. It can manage as many as eight networks, and each network can include as many as 256 nodes. A user-friendly graphical interface provides information to the network operator in a concise, easy-to-understand format containing topology, tabular, and shelf views of the network. Color-coded network summary information and simple drill-down navigation tools provide fast access to critical status information. And, with just a few mouse clicks, the operator can execute remote commands for provisioning and cross-connect configuration.




How It Works: The NodeWizard Element Manager software is a network management and communication tool that allows remote monitoring and control of a system's fiber-optic nodes. The software consists of a Windows®-based application that interfaces to one or more networks via a serial RS-232 or an Ethernet network link. Using fuzzy cognitive mapping (FCM) technology, it polls equipment transponder units in each node of a managed network. The status values are stored in a database on the NodeWizard server. Comparisons to alarm thresholds automatically trigger alarm notifications to the various displays. An alarm summary table provides an overview of all acknowledged and unacknowledged alarms, color-coded by severity. Alarms also can be sent via the Internet to higher-level network management systems using a simple network management protocol agent.

How Much It Will Cost: The cost of this software depends on the desired system architecture and the number of nodes to be managed.



When It Will Be Ready: The software is available now. Clients include a South American mining operation, which uses the system to monitor mining equipment and cameras. The system also would work well in industries such as telecommunication and cable television, in which companies must manage a network of devices scattered across many locations. In addition, the technology could help cable companies monitor the infrastructure needed to deliver movies-on-demand to subscribers' homes.

Who Is Working On It: IPITEK, the result of a merger in 1999 between TACAN Corporation and Tetra Tech Data Systems, developed this product. IPITEK produces optical networking solutions for broadband, digital transport, and network communications. Its products, aimed largely at communications companies, include fiber-optic systems and components, as well as other broadband communications products and advanced sensor equipment. The company also produces optical transceivers and components. IPITEK employs 175 people and occupies about 100,000 square feet of office space and lab/development facilities. For more information, contact Dr. James H. Bechtel of IPITEK at (760) 438-1010 or jbechtel@ipitek.com. The company Web site is www.ipitek.com.



MDA Origins

Through SBIR Phase I and II contracts between 1996 and 1998, BMDO funded the development of FCM technology through TACAN. FCMs have significant advantages over conventional expert systems for battle control and especially for digital network management. FCMs permit the synthesis of knowledge acquired from different sources and also allow adaptive refinement through supervised or unsupervised learning.





A brilliant orange butterfly lands on a child's hat. Using a video camera, his father captures the moment his son sees it—priceless. He wants to make a print of the moment to share with family and friends but the video footage is too grainy. Here is a product that can extract high-quality still images from video.

Video Pics™

How It Helps: Operating on either a Macintosh® or Windows®-based computer, Video Pics software can extract clear, high-quality pictures from any video source, such as a camcorder, the Internet, or television. The software's algorithms are considerably faster and more flexible than methods based on traditional signal processing. Video Pics also can salvage otherwise unusable video images with its ability to zoom and motion-stabilize the video without any loss of detail. The only comparable product is offered by a Massachusetts Institute of Technology spin-off company, but it requires special hardware for use.



How It Works: The software uses proprietary algorithms to mimic how the human eye and brain operate together to process images. When people stare, their eyes capture several overlapping frames of an image and their brains construct a single, high-quality image based on these frames. Similarly, Video Pics software takes overlapping frames of video and produces a high-quality, still image with the sharpness and clarity of 35mm camera photos. The technology can increase the image's resolution so a shot can be reframed and magnified. Its still images can be used to produce 3,200 x 2,400 dpi printed images. Jitter, noise, and compression artifacts also are removed. Brightness can be adjusted without reducing image quality.

How Much It Will Cost: The price of the Video Pics software is \$199 for both Macintosh and Windows-based computers.

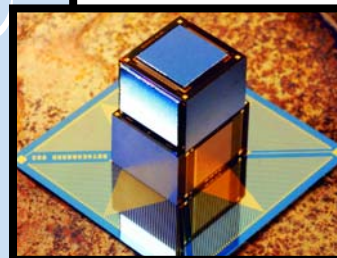
When It Will Be Ready: The software is available now. It has been sold to police and security forces for forensic applications, but has been most successful in the consumer market. The video editing applications are being targeted to professionals, and consumer software is aimed at facilitating e-commerce photo finishing of video frames.

Who Is Working On It: Irvine Sensors Corporation (ISC) developed this technology, and its subsidiary, RedHawk Vision, is commercializing it. RedHawk designs, develops, and produces imaging technologies and software. Founded in 1999, the company has since become affiliated with multiple software developers and established a forensic services unit for tapping the law enforcement market. RedHawk employs nine people and occupies 3,500 square feet of office space in Costa Mesa, California. For more information, contact John Carson of ISC at (714) 549-8211 or jcarson@irvine-sensors.com. RedHawk Vision's Web site is www.redhawkvision.com.



MDA Origins

Video Pics software stems from research performed for BMDO's SBIR program. In 1997 and 1998 under SBIR Phase I and II contracts, ISC investigated a new level of wiring density that could approach the interconnectivity of neurons in the human brain. This led to the development of a new algorithm that emulates the way a brain acquires and retrieves information. BMDO is interested in this technology to improve the speed and accuracy of sensing, discrimination, and systems control functions of ballistic missile defense systems.





Automobile manufacturers are giving voice to vehicle controls. But noise from other vehicles, the wind, the radio, and even the windshield wipers can degrade the quality of voice signals and the equipment's ability to process commands. Here is a product that could improve speech recognition in noisy automobiles.

Clear Voice Capture™

How It Helps: Clear Voice Capture (CVC) software extracts voice signals of interest from noisy environments, improving the accuracy and performance of advanced voice interface systems.



The software emulates the 95 percent voice-recognition accuracy demonstrated in controlled laboratory experiments. Current technology can boast only a 65 percent voice recognition accuracy in a noisy vehicle. CVC software also improves voice quality, especially in noisy environments. For communications networks, it optimizes bandwidth by eliminating noise before transmission. It also improves battery life by as much as 20 percent in voice-recognition-based mobile devices such as personal digital assistants, cell phones, and Internet appliances. Implementation costs are low.


How It Works: CVC software reverses current noise-canceling solutions, which eliminate the low and high frequencies, leaving a mid-level frequency that includes voices and other noise clutter. CVC instead captures and isolates the voice sound using two microphones and mathematical algorithms. The software compares the voice data from each microphone, filters out sounds that do not match, enhances the voice signals, and sends them to a receiver. Voice then can be clearly transmitted to a voice-controlled instrument panel in a car so the driver's command can be understood.

How Much It Will Cost: The price of the commercial software license ranges from \$0.50 to \$5, based on quantity. A development/evaluation kit costs \$149.

When It Will Be Ready: The software is available now. It is being used in hands-free car kits, cell phones, microphones, wearable personal communications systems, hearing aids, and motor homes to improve the quality and accuracy of voice-based interfaces in demanding, noise-filled environments. Companies using CVC in their products include GE, Peiker, Texas Instruments, RTI, Hitachi, THB, and OnStar RiverPark. Many of these companies also co-market CVC technology to their customers. An audio-visual enhancement that could further increase speech recognition accuracy also is being developed.

Who Is Working On It: Clarity, LLC, has licensed and is commercializing the CVC technology. Founded in 1993, Clarity specializes in developing proprietary software products that improve the quality and performance of voice-based products. The company currently employs 21 people and is headquartered in Troy, Michigan, with offices in Campbell, California. Clarity is a spinoff of IC Tech, Inc., the developer and licensor of the technology. For more information, contact Dr. Gail Erten of IC Tech at (517) 349-9000 or erten@ic-tech.com. IC Tech and Clarity's Web sites are www.ic-tech.com and www.clarityco.com, respectively.





MDA Origins

IC Tech developed the mathematical algorithms for CVC under BMDO SBIR Phase I and II contracts in 1997. This technology originally was designed to increase the robustness and sophistication of microphones used in battle management, command, control, and communications systems. For example, it could be used to eliminate digitized noise before transmission, thereby optimizing bandwidth in communications networks.

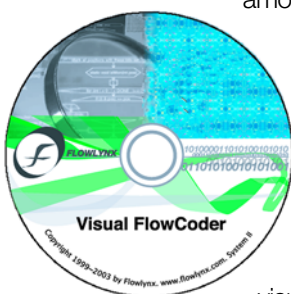




In 1999, a major candy maker suffered a 12 percent loss in its revenues—approximately \$200 million—due to a software glitch. This problem could have been averted through systematic, consistent, and regular peer review and inspection of the software code during its development. But few software developers today conduct this sort of review because it increases development time and cost. Here is a product that could make code review and inspection easier and less costly.

Visual FlowCoder™

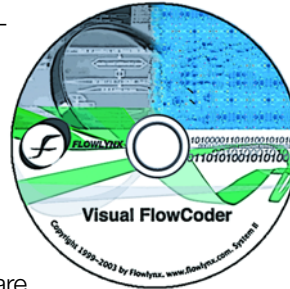
How It Helps: Visual FlowCoder software is designed for programmers and their managers. It automatically builds a graphical code inspection system that can reduce overall project cost and time by 50 to 80 percent. In addition, developers can reduce the number of defects in shipped software by up to 50 percent. Another advantage is that Visual FlowCoder can help detect computer viruses and back doors, improving system security. The software visually documents the code so anyone can understand it. It also supports any amount of code written in any programming language.





How It Works: The product is made of various "intelligent" software agents (small programs dedicated to executing specific tasks) that scan the code on a server. These agents provide useful feedback about potential defects, track the state of a software project, and even automate the porting of code between languages. Using data gathered by the agents, the software creates a visual summary where procedures, functions, and other routines are flowcharted based on the algorithmic flow of the code. This flowcharting tool allows programmers and managers to easily review the functional flow of the code and inspect it in a collaborative environment.

How Much It Will Cost: For one-seat minimal support, the price of the software is about \$2,000. For a 25-seat enterprise server and tools plus additional training, the cost is approximately \$60,000. Extended software training and implementation are available at \$1,800 per day.

When It Will Be Ready: Visual FlowCoder software is available now for Windows® 95, 98, 2000, and NT, as well as Unix/Linux. There are more than 50 licensed commercial and government users, including Chase Manhattan Bank, Lockheed Martin, NASA, and Raytheon.



Who Is Working On It: This product was developed by FlowLynx, Inc., which was founded in 1992 as Ublige Software and Robotics Corporation to develop advanced artificial intelligence hardware and software. In 1998, Ublige was renamed FlowLynx to reflect a new emphasis on flowcharting technology. Today, the company provides a full range of software development services, and its main competence is state-of-the-art re-engineering and management tools for the software development life cycle. It employs four people and occupies about 3,000 square feet of office space in Huntsville, Alabama. For more information, contact Luis Lopez of FlowLynx at (714) 389-9493 or luis@flowlynx.com. The company Web site is www.flowlynx.com.



MDA Origins

Visual FlowCoder software was developed through BMDO SBIR research conducted by Ublige from 1997 to 1999. Under a 1997 Phase I contract, the company determined the feasibility of building intelligent software agents that could analyze source code and map the flow of a large software system. Under a 1998 Phase II contract, it developed prototype software, including new tools enabling users to visualize the flowcoding process. BMDO invested in this technology to improve the quality and maintenance of critical software used in ballistic missile defense applications.





A successful tool is one that was used to do something undreamed of by its author.

—S.C. Johnson

Electrical, Electronic, and Magnetic Devices





In the dark of night, a high-rise apartment building burns. Emergency vehicles pull up to it, and the crews need electricity for lamps, power tools, and computers. But in the time it takes to set up and operate a synchronous generator to run the equipment, lives could be lost. Here is a product that could instantly provide emergency crews the power they need.

Blackbird

How It Helps: The Blackbird auxiliary AC power generator supplies 5 kW of instant, under-the-hood power. It provides 120-volt, 60-Hz power at any engine speed, so a user is free to vary engine speed to match the need of other field operations. Idling an engine to save fuel will not affect the power output. Up to 90 percent of the input horsepower is converted directly into useable electric power with no need for a bulky inverter control box. Since a Blackbird connects by belt directly to the main engine, there also is no need for a separate engine, separate generator, or complex hydraulic drive system. The Blackbird is a compact unit (weighing less than 75 pounds) with simple bracket mounting.



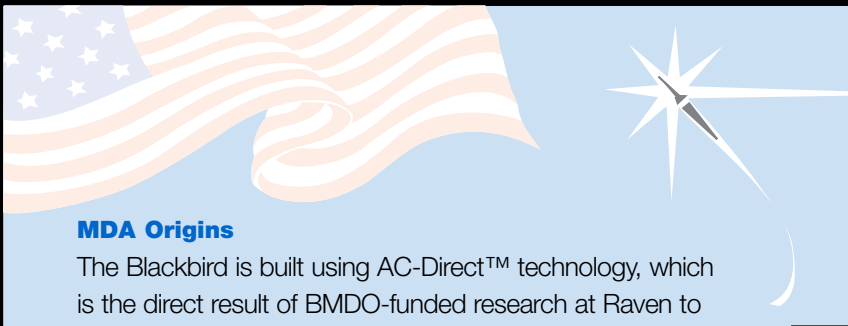
How It Works: The Blackbird power generator is a resonant controller that shapes the output waveform by modulating the level of field coil excitation. As engine speed is varied, the amplitude of the field modulation is adjusted so that the output stays at 120 volts AC. The field control allows a variable-speed engine to produce a constant 60-Hz output with minimal losses. The field control box is easily cooled by natural convection within the engine compartment. To achieve high efficiency, the control system uses two capacitors to capture and store energy for reuse. Net result: up to 5 kW of normal household-type current available instantly from an engine running at any speed.

How Much It Will Cost: Prices vary depending on custom user-specified accessories and installation, with an estimated range of between \$4,000 and \$6,000.

When It Will Be Ready: A series of preproduction units is being readied for beta tests in early 2003, and a commercial unit, aimed at the emergency services market, is scheduled for release in mid-2003.

Who Is Working On It: This product was developed by Raven Technology, LLC. Raven was founded in 1998 by Christopher Tupper and Duncan Wood (formerly of Dirigo R&D, Inc., which was founded in 1990 and continues to exist today with Mr. Tupper as its president) and registered as a limited liability company in 1999. It employs eight people and occupies 3,000 square feet of office space in Brunswick, Maine. For more information, contact Christopher Tupper of Raven Technology at (207) 721-1044 or raven@raventechpower.com. The company Web site is www.raventechpower.com.

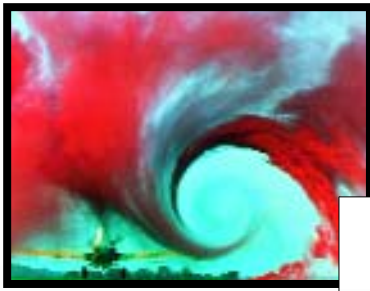




MDA Origins

The Blackbird is built using AC-Direct™ technology, which is the direct result of BMDO-funded research at Raven to develop a lightweight and fuel-efficient mobile electric power generator. Under a 1997 SBIR Phase I contract, researchers proved the feasibility of a 120-volt, 60-Hz, 2-kW unit using a wave-shaping technique that modifies alternating current. Company engineers extended their efforts in 1999 under a Phase II award and developed prototype and field test units with improved efficiency and higher output.





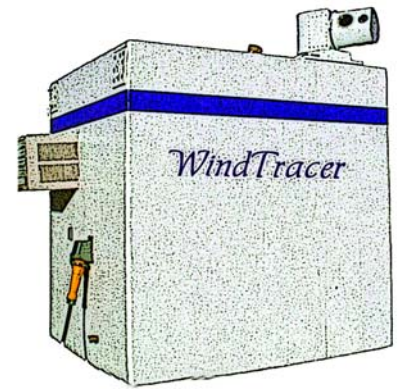
Just as a ship leaves a wake behind it in the sea, an aircraft leaves a wake in the air. The rapidly swirling air in a wake can catch the wings of nearby aircraft, with potentially disastrous results. Because of this danger, air-traffic controllers provide adequate spacing between aircraft—a procedure that ultimately reduces an airport's capacity. Here is a product that could allow aircraft to fly closer together to ease airport congestion.

WindTracer[®]



How It Helps: The WindTracer Coherent Doppler Lidar system detects dangerous air currents created by large commercial aircraft. It helps pilots avoid dangerous patches of air. Air-traffic controllers can direct traffic more efficiently by knowing immediately when it is safe to send another plane down a runway or allow one to land. By optimizing take-offs and landings, airport capacity and flight safety can be increased. Without technology to monitor wake vortices, pilots and air-traffic controllers must rely on experience and educated guesses to determine how to avoid or cope with wind turbulence near airports. Carried aboard aircraft, WindTracer can let pilots at cruising altitudes know the location of nearby areas of air turbulence, allowing them to find a more favorable cruise altitude that will improve flight safety and fuel efficiency.


How It Works: WindTracer measures wind direction and speed using pulsed laser energy at an eye-safe wavelength (in the range of 1 to 2 microns). The system bounces the energy off dust particles or aerosols in the air. It then records and processes the backscatter from particles in real time. Wind direction is determined by scanning an area multiple times from multiple angles. Wind speed is measured by comparing the Doppler frequency shift of backscattered energy with the frequency of the released laser energy.



How Much It Will Cost: A typical installation of the system at an airport can run from \$750,000 to \$1.2 million.


When It Will Be Ready: The product is ready and in use now. WindTracer has provided forecasters at Hong Kong International Airport with high-resolution images of the windshear and turbulence environment at the airport. The airport is near a large mountainous island that sometimes causes windshear and turbulence. Other wind hazards arise due to sea breezes. The customer for the WindTracer in Hong Kong is the Hong Kong Observatory. The Federal Aviation Administration also is using WindTracer to support its Wake Turbulence Research Program, which is focusing on improving capacity at airports.

Who Is Working On It: The product was developed by CLR Photonics, the commercial products division of Coherent Technologies, Inc. (CTI). CTI develops and manufactures laser radar systems for military and commercial customers. Founded in 1984 by Milton Huffaker, the company currently employs 150 people and occupies a total of 40,000 square feet of leased space in Lafayette and Louisville, Colorado. For more information, contact Paul Reveley of CTI at (303) 604-2000 or paulr@ctilidar.com. The company Web site is www.ctilidar.com.



MDA Origins

From 1989 to 2002, CTI received 12 BMDO and MDA SBIR Phase I awards to develop laser-based technologies for missile tracking, discrimination, and kill assessment. For example, the technologies could be used to discriminate between real and decoy warheads released in the mid-course portion of a ballistic missile's trajectory. One notable research effort sought to improve the range of current lidar tracking systems, which would allow MDA to reduce the total number of sensor-monitoring and missile-interceptor platforms.





A critically ill patient clings to life in a hospital intensive care ward with the help of a respirator. Suddenly, the main power source to the building is cut by construction workers digging in a nearby neighborhood. Panic grips the nurses attending the patient because a short moment without power could disable respirators before the hospital's backup generator turns on. Here is a product that could run sensitive equipment for a short duration until backup power kicks in.

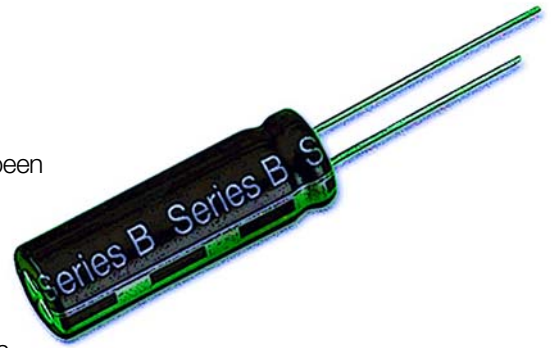
PowerStor®

How It Helps: The PowerStor aerogel capacitor offers big electrical storage capabilities in a small package. The capacitor has extremely fast discharge capabilities and low equivalent series resistance, which make it ideal for pulsed power applications. The device has high energy density (100 times greater than electrolytic capacitors) and high power (10 to 100 times greater than conventional lithium batteries). Because there are no chemical reactions, it can be recharged hundreds of thousands of times without degradation. Other advantages include small size, low cost, and reliable operation over a wide temperature range.



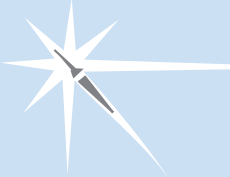

How It Works: The PowerStor aerogel capacitor is based on a novel material called carbon aerogel. Carbon aerogels consist of interconnected nanometer-sized particles with small pores. This monolithic structure leads to very high surface area (the equivalent surface area of 10 football fields) and high electrical conductivity. Capacitors can be made using thin-film carbon aerogel paper as both the positive and negative electrodes. A microporous separator is placed between the two electrodes, creating a sandwich that is wound in "jellyroll" fashion and housed in an aluminum or steel can. The can is then filled with electrolyte and sealed, with protruding leads. When the capacitor is charged, positive and negative ions are oriented along the surfaces of the oppositely charged electrodes. As energy is released, this orientation relaxes back to a disorganized state.

How Much It Will Cost: A full line of aerogel capacitors has been designed for memory backup, pulsed power, and main-power applications. Prices range from \$0.25 to \$30, depending on the type and quantity desired.



When It Will Be Ready: More than 10 million of these devices have been sold in Asia, Europe, and the United States, with new applications emerging monthly. One notable customer, Microsoft, uses the capacitor to power the clock in its new X-Box™ gaming console system. Several aviation equipment manufacturers install the device in their aircraft displays to maintain continuous voltage when switching from one electrical bus to another. Other applications include low-tech toys, valve actuators, and insulin pumps.

Who Is Working On It: Cooper Electronic Technologies is selling these devices. The company acquired this technology by purchasing PowerStor, a subsidiary of the now-defunct PolyStor Corporation. PolyStor licensed the aerogel capacitor technology from Lawrence Livermore National Laboratory (LLNL), which originally developed the technology. PowerStor employs 25 people in its 18,000-square-foot office facility in Dublin, California where the capacitors and their electrodes are made. The business unit also owns manufacturing facilities in Malaysia and China; these plants produce the capacitor's packaging. For more information, contact Marc Juzkow of Cooper Electronic Technologies at (925) 828-6700 or mjuzkow@cooperet.com. The company Web site is www.cooperindustries.com.



MDA Origins

In 1992 and 1993, BMDO funded LLNL to develop the carbon aerogel capacitors for use in lightweight batteries for space applications. The higher energy densities of the capacitors translate into more power stored in a smaller package. Banks of aerogel capacitors could be used to provide energy for electronic subsystems, such as those used for computers and communications.



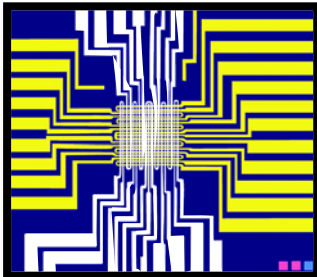


When you press the power button on your television, it instantly comes to life. But do the same thing with your computer and you are kept waiting while it boots up. Here is a product that could allow a computer to turn on instantly.



MRAM

How It Helps: Magnetic random access memory (MRAM) has the power to eliminate the boot-up process and enable instant-on computers and systems that consume less power. By combining the high speed of static random access memory (SRAM) and the high density of dynamic random access memory (DRAM), MRAM could be used to significantly improve electronic products by storing greater amounts of data and providing faster access



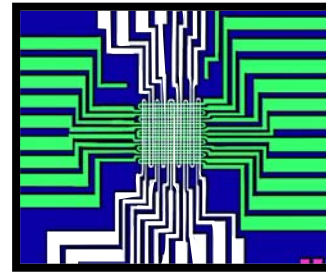
speeds than existing electronic memory. MRAM devices will be considerably cheaper to manufacture than semiconductor-based DRAM and SRAM technology. MRAM is also expected to substantially reduce the power drain for battery-powered devices because it does not need to be constantly refreshed.

How It Works: MRAM consists of two layers of magnetic material separated by a thin, non-magnetic metallic layer through which electrons may pass. Two parallel conducting lines are laid at the top half of this ferromagnetic sandwich. Another set of conducting lines are laid perpendicular to the first set on the bottom half of the sandwich, resulting in a grid of conducting lines. Each point where the top and bottom lines meet represents a bit. When current is passed simultaneously to the top and bottom lines of the bit, data may be read or written. Once data are written, they remain even when the power is removed. This capability is unlike conventional random access memories, such as DRAM and SRAM, that store information only as long as electricity flows through them.

How Much It Will Cost: The goal is to make MRAM competitive in price with conventional memories like DRAM and SRAM.

When It Will Be Ready: MRAM production for high-end computer systems could begin as soon as mid-2003. The product should be in mass production by 2004.

Who Is Working On It: An innovator in this technology is NVE Corporation, a publicly traded company. Founded in 1989, the electronics component manufacturer now specializes in combining magnetically sensitive materials with integrated circuits. MRAM is the primary focus of the company. Because of the capital investment required for large-scale production of memory, NVE made a strategic decision to license its intellectual property and partner with memory manufacturers. Current licensees include Cypress Semiconductor, Motorola, Honeywell, and Union Semiconductor Technology. NVE currently employs 61 people and occupies 21,000 square feet of office space and development facilities in Eden Prairie, Minnesota. For more information, contact Bob Schneider of NVE at (952) 996-1603 or bobsch@nve.com. The company Web site is www.nve.com.



MDA Origins

Much of NVE's early research in MRAM was funded by BMDO's SBIR program. In 1993, NVE won a BMDO SBIR Phase II contract to design MRAM cells down to 0.05 micron line widths using electron-beam microscopy. In 1997, the company was awarded a BMDO SBIR Phase I contract to integrate giant magnetoresistive materials with semiconductor transistors. In 2002, it was awarded an MDA SBIR Phase I contract for magnetothermal MRAM designed to further increase both MRAM density and temperature tolerance. MRAM devices are ideal for BMDO space systems because they are radiation-hardened when combined with a radiation-hardened memory underlayer and can operate over a wide temperature range.



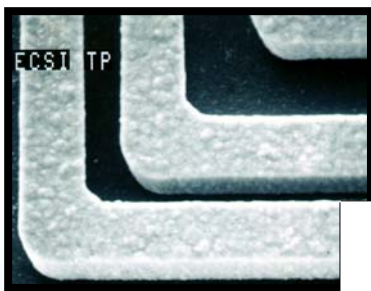


The desire to know is natural to good men.

—Leonardo da Vinci

Electronics Processing





In electroplating, process control is crucial—particularly when electrodepositing small electronic and microelectromechanical devices. Process control is difficult to maintain when the feature size of these devices shrinks below the thickness of the static boundary layer that envelops the substrate being plated. Variations in bulk chemistry and fluid flow are ineffective. Here is a product that allows electroplaters to regain process control.

FIBRoplate™ IKo™

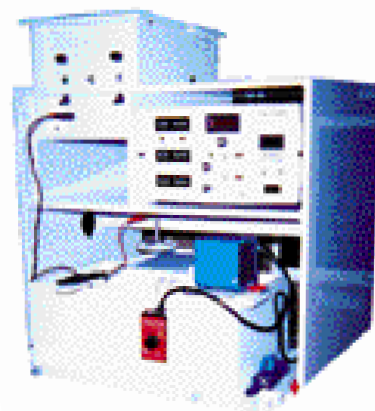
How It Helps: The FIBRoplate IKo electroplating system allows electroplaters to manage the boundary layer thickness. By agitating the electrolyte solution around the features, the boundary layer can be reduced by up to 90 percent, which allows greater process control. Compared to its nearest competitor, the system is 25 percent smaller—it is the smallest electroplater footprint on the market—and consumes 75 percent less electroplating solution.

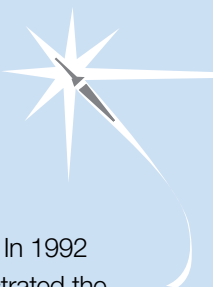

How It Works: FIBRoplate IKo uses unique fibrillic applicators, or brushes, to agitate the electrolyte solution around the features without damaging them. These soft applicators are positioned 5 to 10 microns from the surface. When in motion, they cause circulation of the electrolytic solution near the substrate. This effectively reduces the boundary layer thickness and enables process control. Bulk chemistry and fluid flow can still be used to affect the plating results; however, a new level of process control can be achieved by varying the motion of the applicators.

How Much It Will Cost: The base price for the FIBRoplate IKo is \$30,000. This cost is about half that of its nearest competitor.

When It Will Be Ready: The electroplating system is available now. Bench-top electroplaters for microelectromechanical and nanoelectromechanical applications have been sold to universities and research institutions.

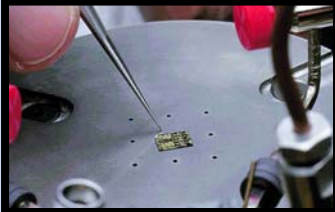
Who Is Working On It: The innovator is ElectroChemical Systems, Inc. (ECSI). ECSI was founded in 1989 by Dr. Igor Kadija. The company focuses on designing, building, and supplying practical, precise wet-processing equipment for micromachining and microelectronics R&D and manufacturing. It retains three subcontractors with expertise in machining, plastics, and electronics design. It occupies a 1,000-square-foot facility in Denville, New Jersey with quality control, wet processing, and bench-top testing capabilities. For more information, contact Igor Kadija of ECSI at (201) 670-8397 or ikadija@fibrotools.com. The company Web site is www.fibrotools.com.





MDA Origins

ECSI was awarded two BMDO SBIR contracts. In 1992 under a Phase I contract, the company demonstrated the electroplating applications of this technology by making copper interconnects on silicon. In 1993, under a Phase II contract, it started building an etching system based on the technology. However, because the cost of developing the etcher proved too high, ECSI returned to the plating application and completed a prototype. Ideally, BMDO could use this technology to create reliable, high-density interconnects for space weapons.





A company wants to supply coated glass to flat-panel display manufacturers. The glass must be coated with a very thin, uniform layer of indium tin oxide (ITO). With conventional sputtering processes, controlling the material deposition on the glass is difficult, and a too-thick, nonuniform layer of ITO could compromise the performance of the display. Here is a product that could enable more process control in these sputtering systems.

IonCell™

How It Helps: IonCell cesium cartridges allow better control over the thin film deposition process, resulting in higher quality thin films. These cartridges can be implemented as a modification to existing proprietary sputtering systems, eliminating the need to purchase new equipment because the modified \$1 million unit can perform like a \$10 million unit. The cartridges are easy to install, similar to an ink cartridge for a printer, and last approximately 200 hours of sputtering time. No special handling or hardware is required.



How It Works: IonCell cesium cartridges supercharge vacuum deposition processes, allowing manufacturers to generate ITO coatings with enhanced and controlled properties. The cartridges are designed to be inserted into an injector assembly, which can be attached to any proprietary sputtering system. This injector transforms a conventional sputtering system into an ionized physical vapor deposition source. In the assembly, a heater heats the cesium cartridge, causing it to expel neutral cesium particles. The introduction of cesium into the process causes ionization of the sputtered material. The negative ions produced by the bombardment of the target are repelled by the target material and are directed toward a substrate. The substrate can be grounded or can be positively biased to attract the sputtered ions, providing a higher level of control over the formation of a very thin, smooth, and uniform layer of material.

How Much It Will Cost: The purchase price of the IonCell cesium cartridges is about \$200 each.

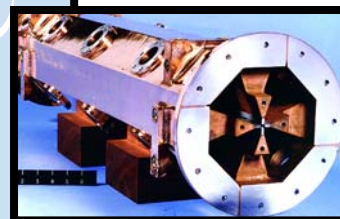
When It Will Be Ready: The cesium cartridges are available now. Hanwha L&C Corporation, a South Korean company involved in plastics, chemicals, automotive parts, and other materials, recently purchased a proprietary sputtering system that incorporates an IonCell cesium-based injector subsystem. The company will use this technology to produce thin-film ITO coatings on glass for organic light-emitting displays.

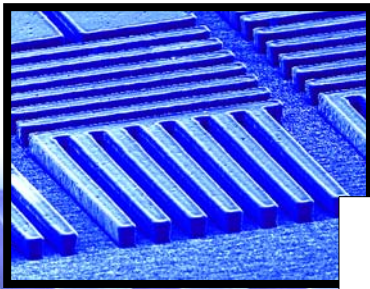


Who Is Working On It: The original developer of the cesium technology was SKION Corporation, which merged with Plasmion Corporation in 2001. Plasmion develops leading-edge thin-film application technology for the display, semiconductor, storage disc, and optical communications industries. The company employs 20 people (9 with doctoral degrees) and occupies a 20,000-square-foot facility that includes state-of-the-art vacuum coating and testing systems and analytical instruments. Additional funding has been provided by The Egg Factory, LLC, a venture capital group. For more information, contact Steven Kim of Plasmion at (201) 963-5450 or skim@plasmion.com. The company Web site is www.plasmion.com.

MDA Origins

Dr. Steven Kim, founder of SKION and Plasmion, developed the fundamental principles of this technology for use in a neutral particle beam weapon with the support of SDIO and BMDO in the late 1980s and early 1990s. In 1996 and 1997 under BMDO SBIR Phase I and II contracts, SKION investigated the use of super-high brightness electron-emission film for field emission displays in ballistic missile defense systems.

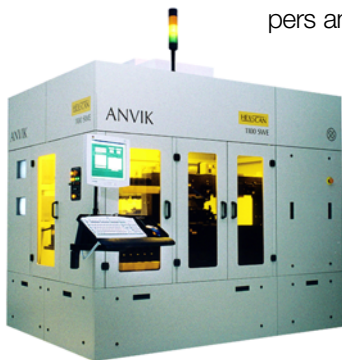




Electronics manufacturers have been frustrated by the limitations of today's lithography and patterning equipment. Standard projection lithography and printing systems can produce small features but have limitations when it comes to large-area substrates. Stepping systems can accommodate larger substrates but have restricted throughput and lower yield. Here is a product that ends the frustrations of electronics manufacturers.

Hex-Scan™

How It Helps: Hex-Scan lithography systems combine large-area imaging capability with high resolution and high throughput to enable high-volume, cost-effective production of a wide range of microelectronic and optoelectronic products. This combination eliminates the limitations of other lithography tools, including contact and proximity tools, conventional projection systems, steppers and scanners, and direct-write machines. Further, these systems are highly modular, allowing for equipment upgrades and user-specified configurations.





How It Works: Hex-Scan lithography systems use patented hexagonal seamless scanning technology to enable operators to deliver the desired resolution over very large substrate areas. The substrate and mask are mounted on a single planar stage that scans in two directions. An excimer laser illuminates the mask from below in a hexagon-shaped region, which is imaged onto the substrate by an all-refractive projection lens. A reversing unit ensures that the image has the same orientation as the object. The single planar stage causes the mask and substrate to move together in a scan-and-repeat serpentine fashion until the entire substrate is exposed. The complementary overlap between adjacent scanning areas produces seamless exposure.

How Much It Will Cost: These systems range from \$600,000 to \$1.5 million depending on the model and its levels of customization and automation. This cost is far less than the \$5 to \$7 million for traditional stepper machines.

When It Will Be Ready: Lithography systems are now available for printed circuit boards, high-density interconnects, optoelectronics, microelectromechanical systems, and displays (both rigid and flexible). Swedish companies Sheldahl and Acreo AB, as well as a Fortune 100 company in the United States, have purchased these lithography systems for volume manufacturing of microelectronic products.

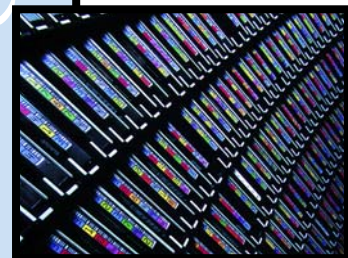
Who Is Working On It: Anvik Corporation developed this product. The company designs, develops, and manufactures advanced optical systems and equipment for microelectronics, optoelectronics, microsystems, and biotechnology applications. It occupies a 12,000-square-foot manufacturing and technical facility, with well-equipped laboratories for optics, electronics, and microelectronic processing, and has powerful software design tools for optical engineering. Founded in 1995, Anvik currently employs 10 people. For more information, contact Marc Zemel of Anvik Corporation at (914) 345-2442 or mzemel@anvik.com. The company Web site is www.anvik.com.

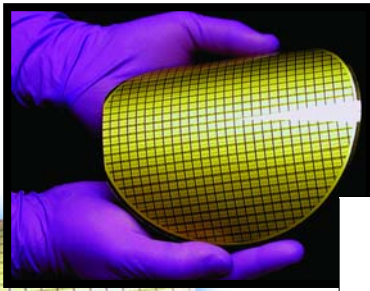




MDA Origins

Anvik's lithography system could help shrink the size and improve the performance of electronic circuitry used in missile defense systems. For this reason, BMDO funded the company's SBIR Phase I and II research, which ultimately resulted in a submicron-resolution, large-area, high-throughput lithography system. Additional research funding was obtained from DARPA, the U.S. Army, the U.S. Air Force, and the National Science Foundation.





A start-up firm develops a better optoelectronic wafer and wants to process the backside without disturbing the frontside. But the devices on the backside are too sensitive to undergo the thinning processes that immerse the entire wafer in etching fluid. Here is a product that allows single-side processing with high yield and at low cost.

WaveEtch™

How It Helps: WaveEtch™ single-sided wet processing system safely thins wafers and shaves production costs. One advantage of WaveEtch's single-sided processing of microelectromechanical and optoelectronic devices is that

it does not affect the side of the wafer with structures or devices already on it. A second advantage is that WaveEtch does not create subsurface damage, thereby protecting applications that are repeatedly heated and cooled or subject to mechanical stress. A third advantage is high yield. Other processes that can thin wafers to equivalent levels involve a two-step process—mechanically grinding down the wafer to a certain level, and then chemically thinning the remainder. Such grinding techniques produce low yields and drive up the costs of chip production. A fourth advantage is the system's low capital cost and cost of ownership, which can be a fraction of comparable tools.

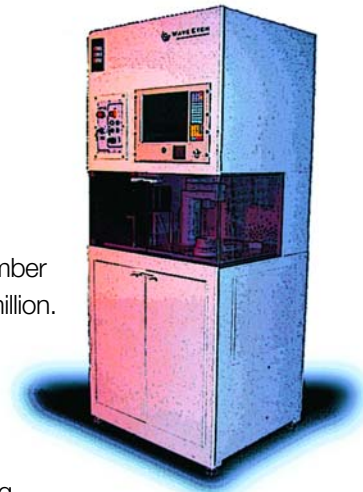




How It Works: The WaveEtch single-sided wet processing system uses a patented process, called dynamic confinement technology (DCT), to thin semiconductor wafers. DCT uses fluid dynamics to confine solutions that "eat away" or etch a wafer surface. This process has been qualified for wafers from 625 microns to 50 microns thick, and can work with virtually all semiconductor materials. It is a cost-effective, high-yield approach to reducing large-area, high-quality substrates with no front-side damage. Only the side being thinned is touched by the solution.

How Much It Will Cost: Depending on options and the number of processing stations, prices range from \$400,000 to \$1.7 million. These prices are one-third to one-tenth that of other thinning processes.

When It Will Be Ready: The system is available now. With more industries moving towards single-sided wafer processing, WaveEtch makes the perfect platform to tap this upcoming and fast-growing market. In fact, some of the world's top 50 wireless, optoelectronic, and high-frequency communication device manufacturers are now using WaveEtch technology to create charge-coupled devices, focal plane arrays, optical nanostructures, and other optical and optoelectronics components.

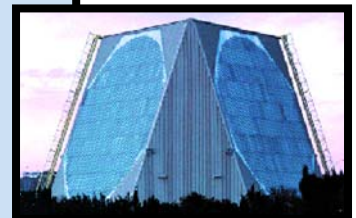
Who Is Working On It: The innovator is Materials and Technologies Corporation (Matech), incorporated in 1992. The company intends to be an industry leader in developing single-sided wafer processing systems. It employs 10 people and occupies 5,000 square feet of office and manufacturing space in Poughkeepsie, New York. For more information, contact Dr. Ricardo I. Fuentes of Matech at (845) 463-2799 or fuentes@matech.com. The company Web site is www.matech.com.





MDA Origins

BMDO funded the development of Matech's wafer-thinning process to produce wide bandgap silicon carbide (SiC) substrates for high-power, high-frequency radar applications. A thinning process that would strip away the sacrificial layers on SiC substrates was required, but not commercially available. In 1996, BMDO awarded an SBIR Phase I contract to Matech to show feasibility and demonstrate DCT to produce large-area SiC-on-insulator-compliant substrates for low-defect, lattice-matched, wide bandgap semiconductor growth. In 1997, BMDO awarded an SBIR Phase II contract to Matech to further develop the DCT process for direct commercialization.



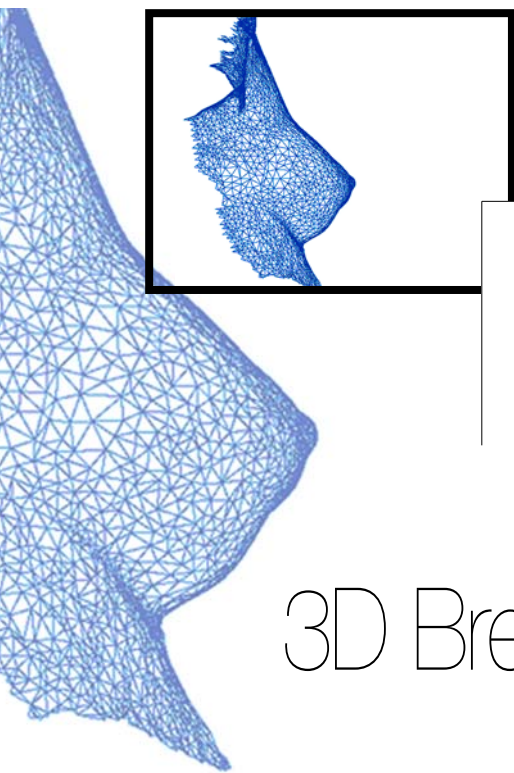


*An expert is a man who has made all the mistakes
which can be made in a very narrow field.*

—Niels Bohr

Imaging





A mastectomy patient opts for breast reconstruction. During surgery, the doctor does his best to visualize the size and shape of the new breast. After the surgery, however, the patient realizes that her breasts do not match. Here is a product that gives surgeons a more scientific method of determining volume differences for breast reconstruction.

3D BreastSim™

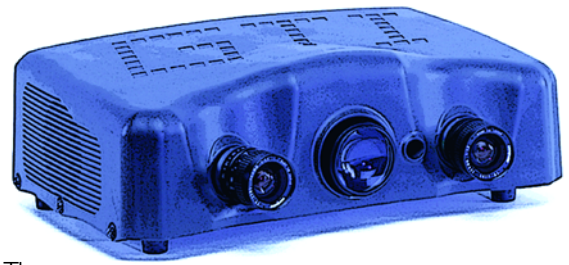


How It Helps: The 3D BreastSim imaging system and software increases the accuracy and speed of breast reconstruction and augmentation and reduction surgeries. Whether in a pre-operative consultation or during surgery, doctors need a quick, accurate method to determine the volume of an existing breast so that the reconstructed one will closely, if not perfectly, match. Traditionally, laser line scanners have been used to provide the data to generate three-dimensional models, but these devices are slow and have difficulty operating when the object being scanned moves, even slightly. The 3D BreastSim imaging system captures full-frame images in less than a second. More than 440,000 data points are collected for each image. A lightweight, compact design makes the system portable and adaptable to nearly any medical environment.

How It Works: The 3D BreastSim imaging system includes a device that projects white light through a cylindrical lens that fans the beam. This beam passes through a linear variable wavelength filter to produce a continuous color spectrum, much like the rainbow effect from a prism. This rainbow of light illuminates the breast. Reflected light is detected by two color charge-coupled devices (CCDs), which convert these reflections into digital signals. Proprietary software uses this digital data to mathematically compute the x, y, and z locations for each pixel of the image created by the CCDs. Once the locations are known for every pixel in the image, a true three-dimensional model of the breast can be displayed.

How Much It Will Cost: The 3D BreastSim and its associated software can be purchased for about \$5,000.

When It Will Be Ready: This product is available now. The 3D BreastSim has been sold to early technology adopters such as plastic surgeons and university hospitals. The technology is also being evaluated for use in doctor-patient planning and communication before breast augmentation/reduction surgeries.

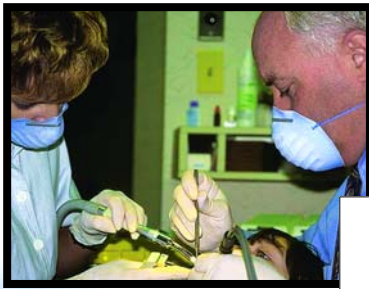


Who Is Working On It: The innovator is Genex Technologies, Inc. (GTI). GTI develops leading-edge electronic imaging technologies and delivers proprietary hardware/software solutions. The company was ranked #257 in the 2002 *Inc. 500*, a comprehensive guide to America's fastest-growing private companies published by Inc. magazine. Founded in 1996 by Dr. Jason Geng, GTI employs 15 people and occupies 7,000 square feet of office and laboratory and development space. For more information, contact Dr. Jason Geng of GTI at (301) 962-6565 or geng@genextech.com. The company Web site is www.genextech.com.

MDA Origins

The product's origin can be traced back to research GTI conducted for BMDO. In 1996, BMDO awarded GTI an SBIR Phase I contract to integrate an innovative 3-D camera with a true volumetric display device. Combined, the two technologies would bring a new level of realism to simulation, training, and battlefield management. A sensor platform of 3-D cameras, for example, could help detect and track incoming missiles by feeding trajectory data to a 3-D display system at the command and control center. In 1997, BMDO awarded GTI a follow-on Phase II contract to develop a prototype.

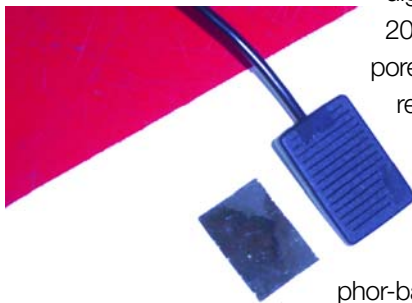




Here is a numbing fact: Fewer than 10 percent of dentists in the United States use digital imaging systems to record, enlarge, store, and transmit x-ray images of a patient's teeth. Digital imaging equipment is often bulky—which clutters small dental offices—and expensive, leading many dentists to continue using traditional film-based systems. Here is a product that makes digital x-ray imaging more attractive to dentists.

Digital Imaging Sensor

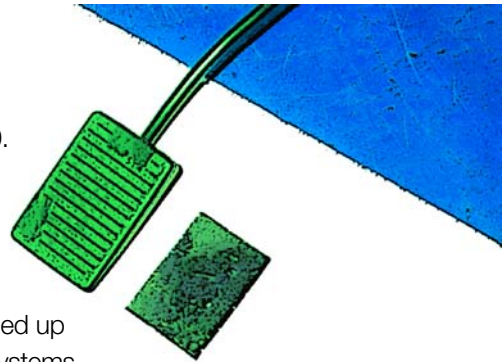
How It Helps: By providing higher resolution, improved contrast, and reduced radiation dosages, the digital imaging sensor may convince more dentists to switch from film to digital x-ray imaging. The device uses doped nanocrystalline (DNC) phosphors that can be modulated to increase light output, thereby enabling higher contrast and requiring less radiation than other digital x-ray detectors. To date, light output has been increased about 20-fold. The containment of the light within the small, closely packed pores of the device's micro-channel plate (MCP) enables increased resolution. The smaller size of the nanophosphor-based scintillator bonded to the complementary metal-oxide semiconductor (CMOS) sensor allows the unit to fit easily inside the patient's mouth.



How It Works: The digital imaging sensor consists of a nanophosphor-based scintillator integrated with a CMOS sensor. The scintillator, which converts x-ray radiation into visible light, consists of an MCP composed of between 2 and 3 million channels per square inch, each deposited with DNC phosphors. These DNC phosphors use quantum-confined atoms to emit above-normal amounts of light when acted upon by radiation. The individual channel walls of the MCP reflectively transmit the visible light generated by the DNC phosphors, similar to optical fiber, toward the CMOS sensor for digital detection. The small channels both enhance and prevent light scattering to help produce high resolution and contrast digital images that can be stored or displayed on a computer screen.

How Much It Will Cost: The digital imaging sensor and accompanying software can be purchased for about \$3,500.

When It Will Be Ready: The product is slated for production in mid-2003. Prototypes have been successfully tested by the leading manufacturers of dental imaging sensors in Europe and Japan. The technology is also being scaled up and evaluated for use in retrofitting current mammography systems.



Who Is Working On It: Nanocrystals Imaging Corporation (NIC) developed this product. The company was founded in 1997 as a spinoff of Nanocrystals Technology (NCT), LP (which has raised more than \$5 million in funding from private investors, mostly doctors) to exploit discoveries in the creation of high-quality digital x-ray images. NIC employs eight people and occupies 3,000 square feet of office and laboratory space. For more information, contact Dr. Rameshwar Bhargava of NIC at (914) 923-1142 or rbhargava@nanocrystals.com. The company Web site is www.nanocrystals.com.

MDA Origins

NCT developed the nanophosphor-based scintillator as part of its BMDO SBIR research. The company had already developed its DNC phosphors when, in 1994, the company applied for and won an SBIR Phase I contract from BMDO. This research aimed to measure the light-output potential of the materials. In 1999, the company won a BMDO SBIR Phase II contract to build the DNC-based scintillator, combine it with a CMOS sensor, and produce high-resolution images. BMDO supported this technology because it could be combined with x-ray, ultraviolet, or visible radiation detectors to create sensitive missile detection and tracking systems.





A deer appears, seemingly out of nowhere, and collides with a car on a secluded highway. The calamitous combination happens more often than people think; one insurance group claims that in 2000, approximately 500,000 deer-automobile collisions resulted in more than 100 human deaths and thousands of injuries. Here is a product that could help prevent these collisions.

Wildlife Protection System™

How It Helps: The Wildlife Protection System provides accurate, real-time warnings of animals approaching the roadways to prevent potentially deadly collisions with motorists. In areas where wildlife-automobile collisions are frequent, highway departments traditionally install bright yellow warning signs. But, after viewing these signs, most people fail to slow down or keep a closer watch for animals near the road. The Wildlife Protection System displays warnings that attract the attention of motorists. When an animal is detected, the system also can automatically trigger the display to show a lower speed limit, further reducing the chances of collision. It can even identify what species of animal is near the road. Because the system can operate in the dark and through fog, rain, and smoke, it also is very reliable.




How It Works: The Wildlife Protection System uses a long-wave-length infrared imaging camera to detect wildlife in a critical area and transmit a signal to any message display, such as a flashing light or digitally illuminated sign. The camera includes a focal plane array, containing quantum well infrared photodetectors (QWIPs), that is highly sensitive to heat energy in the 8- to 12-micrometer wavelength range. This capability allows the camera to see radiation at wavelengths not normally visible to the human eye. Room temperature objects observed at these wavelengths can be seen to radiate the same way red-hot objects glow in visible light. The QWIP array can scan several miles of road and warn motorists long before a collision might occur.



How Much It Will Cost: The price of the product depends on the geography of the area, sophistication of the system, and available infrastructure. Man-made subterranean animal crossings can cost upwards of \$1 million. This type of crossing, which typically covers an area of 300 meters or more, easily could be replaced with a \$125,000 Wildlife Protection System. A larger, more advanced system covering one kilometer or more costs about \$200,000.

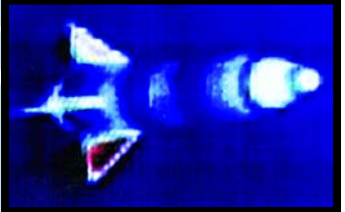
When It Will Be Ready: The product will be available in mid-2003. It is being tested in the Kootenay National Park of Canada. An advanced version of the system, which is being developed, will warn motorists about other objects on the highway, including ice, debris, and even road kill.

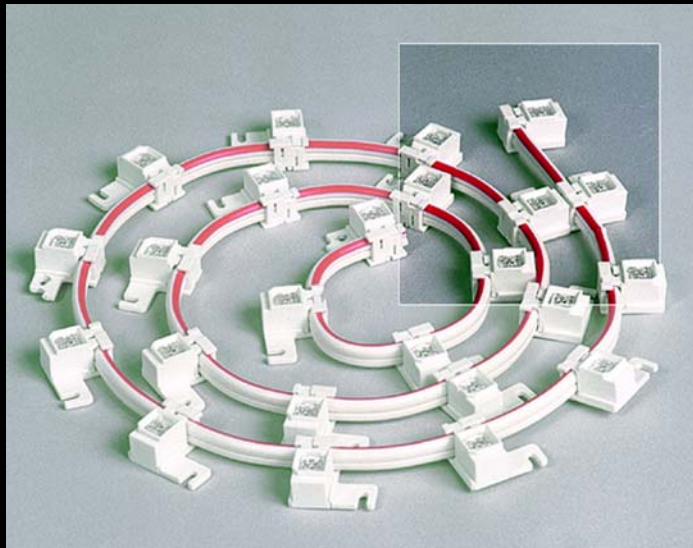
Who Is Working On It: InTransTech, Inc., is commercializing this technology. Founded in 1991, the company applies cutting-edge technology to transportation safety. It employs two people and occupies 1,000 square feet of office space and research facilities. InTransTech has the exclusive rights to transportation applications of the QWIP technology through its parent company, the Rainbow Group. QWIP technology was originally developed by NASA's Jet Propulsion Laboratory (JPL) and licensed by QWIPTech, another subsidiary of the Rainbow Group. For more information, contact Dale Keep of InTransTech at (509) 525-3197 or dalekeep@innw.net. The company Web site is www.intranstech.com.



MDA Origins

Throughout the 1990s, BMDO's Innovative Science and Technology program funded JPL to develop QWIP technology for use in ground-based and space-based infrared surveillance at long wavelengths. The technology could detect unheated objects such as ballistic missiles in mid-course, when the hot rocket engine is not burning.





Don't let what you cannot do interfere with what you can do.

—John Wooden

Optics and Photonics





Parallel arrays of diode lasers, called vertical-cavity surface-emitting lasers (VCSELs), enable communications system designers to break slower copper-interconnect bottlenecks. These devices significantly boost backplane speed in short-distance applications. However, early implementations had difficulty ramping up to the needed volume. Here is a product that reliably and cost-effectively improves backplane speed.

MagnusTM

How It Helps: The Magnus Parallel Optical Interconnect allows communications system designers to cost-effectively and reliably improve backplane speed in short-distance applications. The device delivers huge improvements in the most critical of today's datacom metrics: more gigabits per linear inch on a board edge; more gigabits per Watt of power consumed; more gigabits per unit cost. In addition, its pluggable, connector-based design enables manufacturers to provide bandwidth on demand, upgrading cards in the field with the snap-on optics. The device's footprint is only twice the size of the industry-standard 1 Gb/s small form factor transceiver.




How It Works: The Magnus Parallel Optical Interconnect uses an array of twelve 850-nm VCSELs capable of 40 Gb/s transmission. The module converts 12 electronic signals of up to 3.125 Gb/s each into optical signals, and launches them into a fiber ribbon cable 1 cm wide. Since the transceiver is based on multimode fiber, it is intended for transmission lengths of up to 1,000 feet. In the transmitter module, digital electrical signals flow through the electrical connector, through a circuit board, and into a laser driver integrated circuit. The circuit translates the digital data into small current pulses to drive the VCSEL array. The light beams from the VCSEL array are aligned into the fiber ribbon, which guides them to the receiver module. At the receiver, the functions of the transmitter take place in reverse order.



How Much It Will Cost: Prices for the interconnect modules start at \$1,000 per transmitter/receiver pair in low manufacturing volumes. The product ultimately will sell for much less than that in high volume.

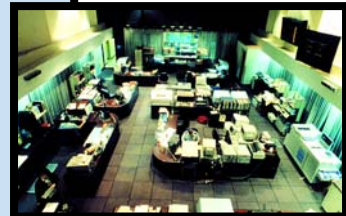
When It Will Be Ready: The product is available now. It works well for very short distance data transfer as well as for metropolitan area access applications. Vendors of routers and telecommunications switches have purchased it.

Who Is Working On It: The innovator is Picolight Corporation. Founded in 1995 by technical officer Jack Jewell and chief executive Stan Swirhun, the company makes VCSEL-based fiber-optic transceiver components and sub-systems for telecommunications switches, storage area networks, and enterprise networks. In mid-2002, it completed its fourth round of funding, raising \$27 million from institutional investors. Investment in Picolight now totals \$80 million. The company employs 100 people and occupies space in Boulder and Louisville, Colorado. The Boulder facility, which serves as the company's headquarters, totals 37,000 square feet. The Louisville facility is 30,000 square feet and can be expanded. For more information, contact Jack Jewell of Picolight at (303) 530-3189 or jack.jewell@picolight.com. The company Web site is www.picolight.com.



MDA Origins

BMDO played a major role in helping Picolight develop the base technology used in this product and others. From 1996 to 1998, Picolight won seven SBIR Phase I and four Phase II contracts to research VCSEL-based laser technology, the same technology used in the parallel optical interconnect module. BMDO was interested in advancing the development and manufacturing of this technology because it could significantly improve the quality and speed of fiber communications systems used in missile defense.

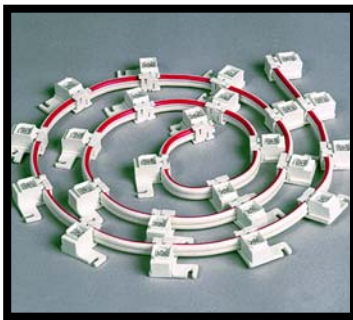




Big neon letters create eye-popping displays that attract customers to strip malls, restaurants, grocery stores, and retail establishments. But the neon bulbs are not energy efficient and are difficult to maintain—excessive vibrations cause them to break frequently. Here is a product that provides a better solution for outdoor displays.

Tetra™

How It Helps: The GE Tetra LED System is more durable and up to 80 percent more energy efficient than standard neon tubes used in outdoor displays. It can also last up to 100,000 hours while delivering maximum efficiency and the same high light output as clear red neon. Longer life means fewer system changes, lower maintenance costs, and fewer disruptions due to burned out

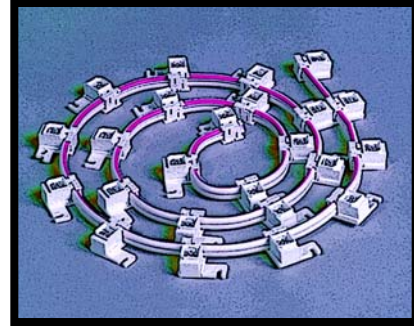


tubes. The forward-facing light-emitting diodes (LEDs) are placed in flexible packaging for easy installation in new or retrofit applications. These devices also are more resistant to vibrations than neon tubes.

How It Works: The GE Tetra LED System uses ultrabright LEDs made from aluminum-indium-gallium-phosphide (AlInGaP) and indium-gallium-nitride (InGaN) materials. A metal-organic chemical vapor deposition system called TurboDisc™ is used to fabricate


AlInGaP and InGaN wafers. The TurboDisc system is vacuum-loadlocked and uses a high-speed, rotating substrate holder. To produce an epitaxial layer, feed gases are introduced into the reaction chamber, where high temperatures dissociate the gases into constituent elements. These newly liberated reactants combine at the substrate wafer surface, where the proprietary TurboDisc geometry ensures uniform temperature and reactant gradients to form the compound layers.

How Much It Will Cost: The price of the GE Tetra LED System varies, depending on the size and length of the channel letter signage.



When It Will Be Ready: This product is available now. It is being sold for outdoor use only. LED colors include red, blue, cyan, green, red-orange, and yellow-amber. It is shipped in reels that can be cut to size on location. In one notable application, numerous strands of GE Tetra LED Systems were placed on the National Christmas Tree, displayed in Washington, D.C.

Who Is Working On It: GELcore, LLC, a joint venture between GE Lighting and EMCORE Corporation, developed this product. Founded in 1999, the company develops, manufactures, and markets LED-based lighting solutions. In addition to the GE Tetra LED System, its product line includes LEDs for traffic signals, indoor signage, automotive displays, and specialty lighting applications. GELcore has more than 200 employees and occupies more than 100,000 square feet of office space and development/manufacturing facilities. For more information, contact Alex Franco of GELcore at (216) 606-6612 or alex.franco@gelcore.com. The company Web site is www.gelcore.com.



MDA Origins

Through several SBIR contracts, BMDO funded early work at EMCORE to optimize the TurboDisc system for gallium arsenide film growth, and later funded EMCORE's initial research on group III-V compound semiconductors, most notably GaN. BMDO was interested in these components for many uses, including high-temperature electronics, display technologies, ultraviolet laser diodes, devices for the detection and recognition of spacecraft, and space communications.





A university has campus facilities spread all over a major metropolitan area. Digging up streets or purchasing rights-of-way and laying fiber-optic lines from one building to the next would be prohibitively expensive and could take years. Here is a product that quickly establishes an affordable, robust, high-speed, and high-bandwidth telecommunications network.

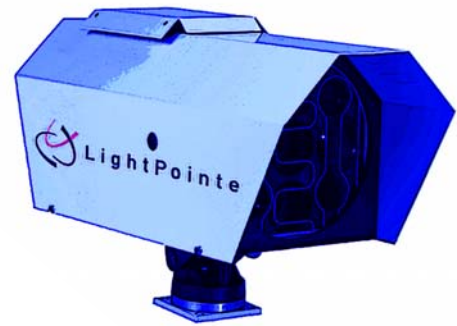
FlightSpectrum™

How It Helps: The FlightSpectrum free space optics system is fiber-optics without the fiber. Free space optical communication is both a substitute for and a supplement to fiber-optic cable links. In either case, deployment of free space optical equipment is a cost- and time-effective approach that has the additional advantage of redeployment flexibility (or no permanent fixed infrastructure). Because free space optical equipment operates at frequencies above 300 GHz, it requires no licensing in the United States. Some of its applications would be impossible to duplicate with fiber optics, such as ship-to-port, dirigible-to-station, or terrestrial point-to-point communications, where laying cable is prohibited for regulatory or political reasons.



How It Works: The FlightSpectrum free space optics system incorporates three high-powered lasers, separated from each other by approximately 200 mm and individually operating at 1,550 nm wavelength. These lasers safely transmit signals through air to multiple, spatially separated, large-aperture receiving lenses. Transmitting and receiving equipment is combined in a "transceiver," which can be stationed at any convenient space, such as on a rooftop or even in an office behind a window. The technique of separating the laser beams is called "spatial diversity" and it solves problems of atmospheric turbulence and dense fog. FlightSpectrum is protocol-independent equipment and provides carrier-grade reliability at a data transfer rate of OC-48 (2.5 Gb/s) through dry air at distances of up to one kilometer.

How Much It Will Cost: Costs per pair of FlightSpectrum transceiver units varies, depending on desired reliability, transfer data rate, and management software: \$15,000 to \$20,000 for 20 Mb/s; \$20,000 to \$25,000 for 155 Mb/s; and \$100,000 for 2.5 Gb/s.

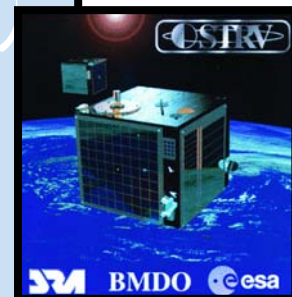


When It Will Be Ready: The product is available now. The manufacturer meets customer demands for communications equipment directly and also indirectly through service providers. Company products accommodate any protocol, connect to existing network equipment, and require no licensing.

Who Is Working On It: LightPointe Communications, Inc., developed this product. In 2000, LightPointe moved its San Diego headquarters to a new location in the city, a 27,000-square-foot building that also will serve as a manufacturing facility for North American customers. Currently, however, a majority of the manufacturing is done at a subsidiary (LightPointe Europe, GmbH) in Dresden, Germany, at a 30,000-square-foot facility. The company also maintains a development laboratory called the Advanced Networking Lab in Boulder, Colorado. LightPointe employs 90 to 100 full-time-equivalent people. For more information, contact Jeff Bean of LightPointe at (858) 643-5200 or jbean@lightpointe.com. The company Web site is www.lightpointe.com.

MDA Origins

LightPointe traces FlightSpectrum's origins back directly to research funded by BMDO in 1998 to 2000. In 1999, BMDO awarded an SBIR Phase I contract to LightPointe for a digital radio backup system for multi-Gb/s terrestrial laser communications links. In 2000, BMDO awarded a follow-on Phase II contract to design a transceiver that combined both terrestrial laser and radio backup functions. Today, the radio frequency backup is used as an out-of-band management device.





A petroleum company blends a variety of chemicals to produce different grades of gasoline. But to measure the makeup of each final product, samples must be taken and then transported from the field to the lab for detailed analysis—a process that can take up to eight hours, slowing gasoline production. Here is a product that performs real-time monitoring of chemicals.



How It Helps: The PI-200 Raman Analyzer allows real-time analysis of chemical concentrations in sample streams, which can significantly improve quality control and process monitoring for industrial users. Compared with conventional equipment, the PI-200 is more rugged and can be used in many different industrial environments. Its compact design makes it suitable for field use, and the elimination of moving parts makes it low maintenance. Moreover, the analyzer's design can be used with any existing high-power diode laser, giving the system a large wavelength selection and, therefore, greater flexibility in detecting materials.



How It Works: The key to the PI-200 Raman Analyzer is an external-cavity-stabilized, narrow linewidth, near-infrared diode laser that offers high power and long life. In the analyzer, laser light is focused into an excitation fiber connected to a remote Raman sample cell. Inside the cell, the light interacts with the sample to be characterized. Raman scattered light emanating from the sample is guided down one or more collection fibers to the Raman spectrometer. The spectrometer passes the optical signal through a filter, an optical slit, and a diffraction grating. The signal is then transmitted to a charge-coupled device, which converts the optical signal into an electronic one. A computer analyzes the electronic signal and converts it into a graphical representation of the chemical analysis of the sample stream.

How Much It Will Cost: A laboratory version of the PI-200 costs about \$80,000, while a process control system using the device will cost more than \$120,000. A less sophisticated model for educational and quality control applications, called the PI-20, costs around \$33,000.



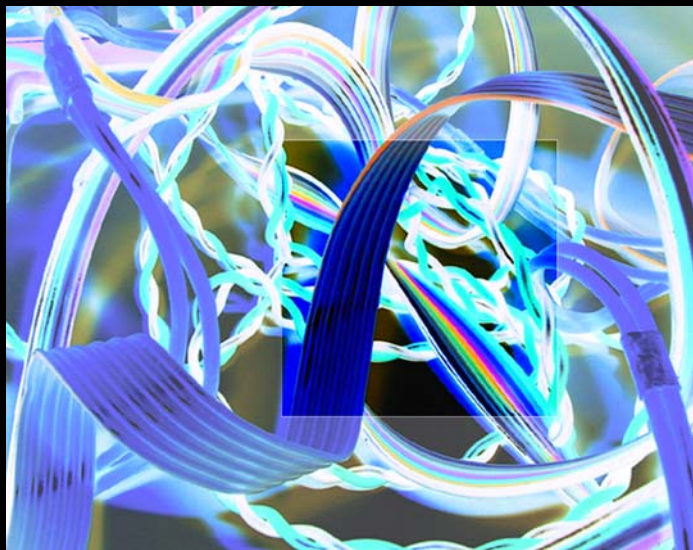
When Will It Be Ready: The analyzer is available now and can be purchased through six U.S. sales representatives as well as dealers in Europe and Japan.

Who Is Working On It: Process Instruments, Inc., developed the analyzer. Founded in 1994, the privately held company develops Raman spectroscopy instrumentation specifically for industrial process monitoring. Process Instruments currently employs eight people and occupies about 5,000 square feet of development and manufacturing space in Salt Lake City, Utah. For more information, contact Dr. Lee Smith of Process Instruments at (801) 322-1235 or lsmith@process-instruments-inc.com. The company Web site is www.process-instruments-inc.com.

MDA Origins

Process Instruments developed the PI-200 through BMDO SBIR Phase I and II contracts in 1998 and 1999. Raman spectroscopy instruments could prove valuable for quality control and process monitoring during the manufacture of key components for terrestrial and space-based ballistic missile systems. In 2001, BMDO awarded Process Instruments an SBIR Phase I contract to further develop its Raman spectroscopy system for testing the chemical state of new and aging rocket motors. Rapid, in situ determination of solid rocket propellant chemistry could greatly reduce the need for destructive testing.



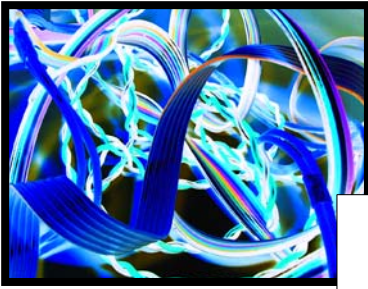


*Not everything that can be counted counts, and
not everything that counts can be counted.*

—Albert Einstein

Acronyms and Abbreviations





The fields of science and technology are awash in acronyms and abbreviations that, for the uninitiated, often cause confusion and frustration. Using undefined terms disrupts the lines of communication and prevents the conveyance of important information. Here we seek to end this needless practice and offer a comprehensive listing of all the acronyms and abbreviations used in this publication.

Acronyms and Abbreviations

BFW	Business Focus Workshop
BMDO	Ballistic Missile Defense Organization (precursor to MDA)
CCD	charge-coupled device
cm	centimeter
CMOS	complimentary metal-oxide semiconductor
CTE	Commercial Technology Exploitation
DARPA	Defense Advanced Research Projects Agency
DCT	dynamic confinement technology
DNC	doped nanocrystalline
DOD	Department of Defense
DOE	Department of Energy
dpi	dots per inch
DRAM.....	dynamic random access memory
FCM	fuzzy cognitive mapping
FEMA	Federal Emergency Management Agency
GaN	gallium nitride
Gb/s	gigabits per second
GHz	gigahertz
HVPE	hydride vapor phase epitaxy
Hz.....	hertz

ITOindium tin oxide
 JPLJet Propulsion Laboratory
 kWkilowatts
 LEDlight-emitting diode
 lidar.....laser radar
 LLNL.....Lawrence Livermore National Laboratory
 m²gmeters squared per gram
 Mb/smegabits per second
 MCPmicro-channel plate
 MDAMissile Defense Agency
 mmmillimeter
 MRAMmagnetic random access memory
 NASANational Aeronautics and Space Administration
 NISTNational Institute of Standards and Technology
 nmnanometer
 NTTC-WONational Technology Transfer Center-Washington Operations
 ohm-cmohmic-centimeters
 PCpersonal computer
 QWIPquantum well infrared photodetector
 R&Dresearch and development
 SBIRSmall Business Innovation Research
 S/cm.....siemens per centimeter
 SDIO.....Strategic Defense Initiative Organization (precursor to BMDO)
 SiCsilicon carbide
 SRAM.....static random access memory
 STTRSmall Business Technology Transfer
 TAR.....Technology Applications Review
 VCSELvertical-cavity surface-emitting laser
 W/m-Kwatts per meter-kelvin

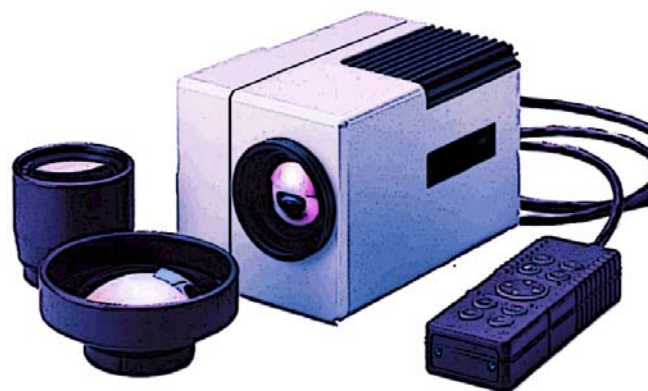


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2003 Technology Applications Report

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Writer/Editor	Patrick Hartary
Production Manager/Editor	Lisa Hylton
Contributing Writers	Adam Gruen, Tabatha Spitzer, Scott Tillett
Design and Layout	Renan Kiper
Technical Advisors	Bill Meyer, Joel Price, Jeff Reynolds, Duane Zieg

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